RADIO BROADCAST

VOLUME IX

MAY, 1926, to OCTOBER, 1926

GARDEN CITY NEW YORK
DOUBLEDAY, PAGE & COMPANY
1926

INDEX

(*Illustrated Articles. Editorials in Italics)

AUTHORS

PORTRAITS

(*Portraits in "The March of Radio")

Win $100.00 in Universal Reception Contest

Thomas H. Butler

The Grand Prize of $100.00 in the Radio Broadcast "Universal" Reception contest has been awarded to Mr. Thomas H. Butler, 427 St. Marks Avenue, Brooklyn, New York. The list of stations tuned in by his "Universal" include 120 stations.

The following extract from Mr. Butler's report expresses his views on the "Universal". "The Universal has given me more pleasure than any set I have owned. I am a DX fan. As my reward I am very thankful to Mr. Lynch to give me and any one a good receiver that I can be satisfied with. My opinion is that the Universal is 'The Ideal Receiver' ".

Mr. Butler is 29 years old, married and a book binder by trade. He took home his first set of parts with which to build his first radio set just two years ago. Since that time he has constructed practically all of the popular circuits.

Mr. Butler, we congratulate you upon the splendid performance of your Universal and your success in winning the Grand Prize in the Radio Broadcast Universal Reception contest.

General Radio Co.
Cambridge 39
Mass.

An Unfailing Source of "B" Voltage

Build a Practical "B" Eliminator

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Rectifier Transformer
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For a dependable plate supply unit which will improve the operation of your set, and will require no attention other than its original installation build a "B" eliminator of General Radio parts.

Write to-day for descriptive data on the General Radio Rectifier Transformer and Filter Choke, and get our circular with full instructions for building a practical "B" eliminator.

GENERAL RADIO COMPANY
Cambridge, Mass.

GENERAL RADIO CO.
INSTRUMENTS ★
Behind the Panels of Better Built Sets

RADIO BROADCAST

MAY, 1926

Willis K. Wing, Editor

Keith Henney, Director of the Laboratory — John B. Brennan, Technical Editor

Vol. IX, No. 1

CONTENTS

BEHIND EDITORIAL SCENES

WITH this number of the magazine, Radio Broadcast begins its fifth year. The first copy was dated May, 1922. During the last four weeks, a large volume of correspondence has come in to the editorial offices, commending our policies, praising the quality of the general and the strictly technical articles which we have been publishing, and very decidedly expressing the hope that we will continue along the lines which we have been following. There will be no change of policy and, reviewing our editorial schedules for the next six months, we can promise to our readers some extraordinarily interesting material.

OLD timers and new timers of radio will find James M. Baskerville's "Breaking Into the Wireless Game" full of the charm that wireless—now radio—holds for all of us. Mr. Baskerville is especially well qualified to write of those early days, because there are not many who antedate him in point of practical experience. Another one of Austin Lescarboura's articles about the development of the commercial broadcast receiver appears on page 28. Home constructors who build their own will read with interest of the many technical and manufacturing obstacles which must be overcome before the complete factory-built receiver reaches the hands of that much discussed person, the ultimate consumer. Those who are still weighing the advantages of using the new types of condensers recently developed will find Kirk Morcross' article on page 33 of real assistance. Mr. Morcross is a radio research engineer of excellent standing, and we feel that his article is more than usually complete.

ALTHOUGH we have no quarrel with the many enthusiasts whose chief radio pleasure is in pulling in stations at a great distance from their homes, there are still a great number of listeners who are interested chiefly in their local program. That is the reason for the design of "Radio Broadcast's Local Receiver." No claims whatever are made for its distance-getting abilities, but the receiver is simple to build and easy to operate, and delivers very excellent audio quality. James Millen, who has become known to readers of this magazine as an authority on current supply devices, has in this issue, another of his helpful articles, this time on trickle charging. Carl Dreher, whose comment about broadcasters and broadcasting, always informative and interesting, and frequently humorous, has had something to say recently in his department about the technical methods of broadcasting, how outside wires are rigged, the placement of the microphones, and other valuable notes for the broadcaster. This month he tells more about how the outside wire connections, so essential to every station, are "equalized," and some of the problems which must be solved in their use.

THE next Radio Broadcast will contain details of a circuit which, while not revolutionary in itself, does contain some very interesting ideas, many of which will provide food for thought and experiment to constructors for many months to come. The second of Howard Rhodes's articles on wavetraps and their use will appear in this number, as well as a report of some extremely interesting observations made by Dr. Greenleaf W. Pickard on radio transmissions in the broadcast band. Many listeners have wondered at the poor long distance reception during the last six months and Dr. Pickard's figures reduce generalities to actual data.

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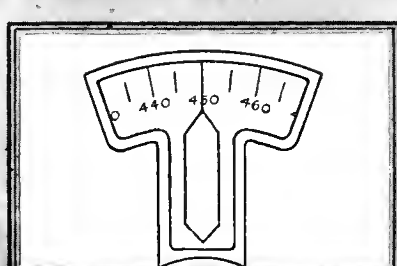
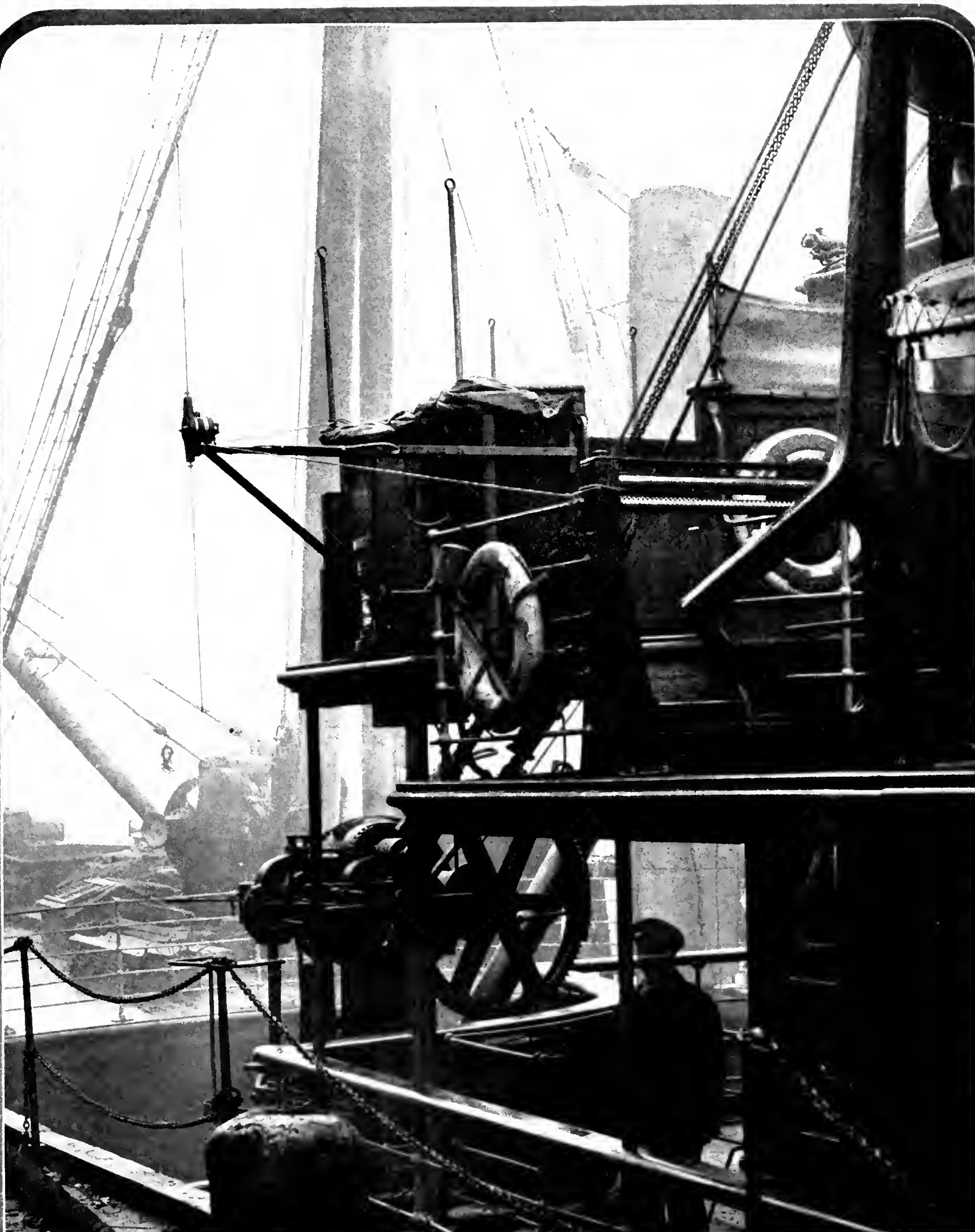


One Tuning Control—Calibrated in Meters!
Select your program, turn up its wavelength and in comes your station.

No Seasonal Models, Continually Developing Refinements



THE NEW MARCONI DIRECTION FINDER ABOARD A BRITISH SHIP

Senator Marconi's beam transmission has been experimentally applied to marine direction finding. South Forland Light, near Dover, is equipped with a transmitter, operating on 49,900 kc. (6.09 meters). The shore station sends signals in a beam 15° wide and a different Morse signal is sent as the beam points successively to different points of the compass. On the bridge of the ship, the observing officer listens on a simple receiver and notes the letters sent as the beam flashes past the ship from the shore station. The letters correspond to letters on a chart which show the beam's direction. The antenna in the illustration is the short wire at the end of the bridge

RADIO BROADCAST

VOLUME IX NUMBER 1

MAY, 1926

Breaking Into the Wireless Game

How Wireless Stations Were Installed and Operated Twenty Years Ago—When 200 Miles Was a DX Record and Amplifiers Were Unknown—How a Young Man Took Up Wireless in 1904

By JAMES M. BASKERVILLE

IN THE fall of 1904, a young man with no particular ambition and a roving disposition, left his home in the South and, proceeding to New York, became the first class helper to a second class electrician.

And by the time a few months had elapsed and winter had set in, I—for this young man was the writer—had considerably enlarged my electrical vocabulary and taken on a veritable load of self confidence. When it became real winter, however, my comfort-loving nature began to revolt at the daily labor of cutting pipe threads and lugging two tool kits usually up flights and flights of steps leading to exposed construction jobs. Blizzards raged endlessly, and the mercury lay low in the cold grip of true winter weather. The vagaries of New York winter climate did not exactly contribute to the desire for an outdoor job, and I, coming as I did from the South, felt the City's hurricane-like gusts keenly. Is it any wonder then, that I had an impelling desire to change my vocation?

My father had written of a Mr. McRae who had been down South selling stock for a "wireless telegraph" concern located at 42 Broadway, New York. Mr. McRae, it transpired, had claimed that it really had at last become possible to send telegrams many miles without any wires intervening. To a hard working wireman like myself, such a statement seemed truly and grossly exaggerated, to say the least. However, the twang of the phrase "wireless telegraph" caught hold of me—curiously mystified me, and I decided to investigate matters on my own.

On Friday, February 3rd, 1905 (this my diary tells me), I stepped over the threshold of Number 42 Broadway, with the avowed intention of convincing Mr. McRae that I was a born wireless man.

Mr. McRae was in but at the time, busy. He would grant me a short interview presently,

Shortly I was in his presence. Could I see the wireless outfit? Well, hardly to-day, for he had a lot to do. How did it work, and how far? Again he could hardly tell me offhand, but if I would care to call again in a few days when he was less busy, perhaps then I might be able to glean a little more information. I confided that my real object in the visit was a job. That was impossible right away, he said. We did agree on one thing, however. He said he was sorry. So was I. And with a "Good day. Call again" ringing in my ears, I left the room which held so many interesting possibilities for me.

AN OLD-TIME RADIO TELEGRAPH STATION
The United Wireless Telegraph Company station at Russian Hill, at San Francisco which carried on a commercial ship-to-shore business. These early wireless stations were the marvel of their day. Many boys, mechanically and electrically inclined, fairly ached to learn the "wireless" just as boys do to-day. Mr. Baskerville's story tells how he started in the "game" when wireless sets were as rare as vials of radium

Perhaps I should have been satisfied with that, but as I stepped to the corridor the door of the "General Manager" loomed up ahead of me—a new and unexpected find that halted me. I stepped in without compunction and introduced myself to that genial gentleman, Mr. C. C. Galbraith, familiarly known to all oldtimers as "C. C. G." He asked what I could do, and I told him that I was a first class electrician and looking for a job installing wireless telegraph stations (I hadn't seen one yet, but that didn't worry a youth of twenty). He looked interested, and asked if I knew anything about wireless. "Not yet, but I'm going to take it on," I replied. So he wrote me a pass to the station on the roof and said, "Tell Birchard to post you up on the equipment and let me know how you like it."

Cornered on the elevator machinery deck, twenty-three flights above the street, was a little three-room construction—the laboratory, working office, and operating room of the De Forest Wireless Telegraph Company.

So cold was it when I entered the operating room that I at first thought the amiable gentleman there had on ear muffs, but, on closer inspection, they turned out to be, head phones. He was seated before a table on which was a large telegraph key, a three-pole knife switch, some delicate and peculiar looking instruments, and a piece of pie. I realized that it was lunch time, and in order to disturb no one during this important event, quietly backed out and started to size up the surroundings.

There was no one in the office or laboratory and I was upon the windy roof studying the mass of wires from the hundred-foot mast when Mr. Birchard called me from below. He appeared to be all set for the afternoon now, and in the pink of an agreeable humor.

THE FIRST LESSON IN WIRELESS

IF HIS explanations of the equipment fell short in lucidity, he made up for it in speed and brevity. He stated facts as so, and never risked a reason. The gist of his remarks was something like this:

Upon a little box a glass point dipped into a rubber cup—the electrolytic detector—most sensitive known. The head phones connected to this box. The oblong instrument was a three-slide tuner, boxed also, with the sliders protruding through slits. (In damp weather, try to move them). This was for tuning-in incoming signals. Manipulating these little sliders, up or down, did to the receiving circuit what tuning a violin string did to a violin, he said. Things grew clearer.

Having mastered the receiving side, we moved rapidly to the sending. In almost a breath and with a sweeping swing of the arm, Birchard followed the action from d. c. to a. c., to key, to transformer primary; from secondary to spark gap, to helix, to anchor gap, to antenna, and on to ships at sea. He particularly said that "juggling" the helix clips affected the sending side just as the sliders did the receiving.

We were now ready for practical demonstration. I hadn't absorbed quite all of the lesson, but was willing to wait. Birchard connected on an extra pair of phones, and I listened-in. Nothing on just now. "Yes. There's VN after a ship," he said. But there was no sound in my phones. In fact, after the tuner-violin string talk, I half expected to hear some music. But none was there, and I doubted the presence of any sound.

Birchard laughed contentedly when I said I heard nothing. I measured agreeably up to his expectations as just an ordinary individual, while he of the wireless knowledge soared on high. "You know you have to have wireless ears," he confided. I didn't know, but agreed with him.

Under Birchard's insistent persuasion there developed a faint suspicion of something in my head phones. The faint something got stronger until I could distinctly hear the buzzes generated in New Haven. This wasn't music. These buzzes were telegraphic code, and appeared quiet different from the clicks of a telegraph sounder, Evidently I was beginning to develop "wireless ears." Birchard asked me if I could tell what VN was saying. No—but I thanked him for the compliment, anyway. After listening awhile, he suddenly looked around as if to see whether all was clear, and said, "He's after me." As he reached for the starting box, I moved in closer and took off the ear phones in order to miss nothing.


Mr. J. M. Baskerville, Dean of the Wireless Department,

and whose photograph appears herewith, entered the wireless service in Feb., 1905, being among the pioneers in that field. Mr. Baskerville has had charge of some of the most important land stations on the Atlantic coast, including Galilee, N. J., Charleston, S. C., Savannah, Ga., Atlanta, Ga., and the main office of the United Wireless Telegraph Company, 42 Broadway, New York. He has also served as aerographer and electrician on more than a score of ocean liners. He gained the distinction of holding the world's first long distance record in 1905 by holding communication for a distance of 1576 miles. He handled the first wireless communication between Chicago and New York in 1909. He saved a schooner in the Gulf of Mexico in 1906 by getting quick assistance from Havana. He also has the record of never having come into port with any wireless apparatus broken down. He has traveled over 300,000 miles as an aerographer (wireless operator). In 1908

Mr. J. M. BASKERVILLE,
Wireless Engineer.

AFTER "BREAKING" INTO THE BUSINESS

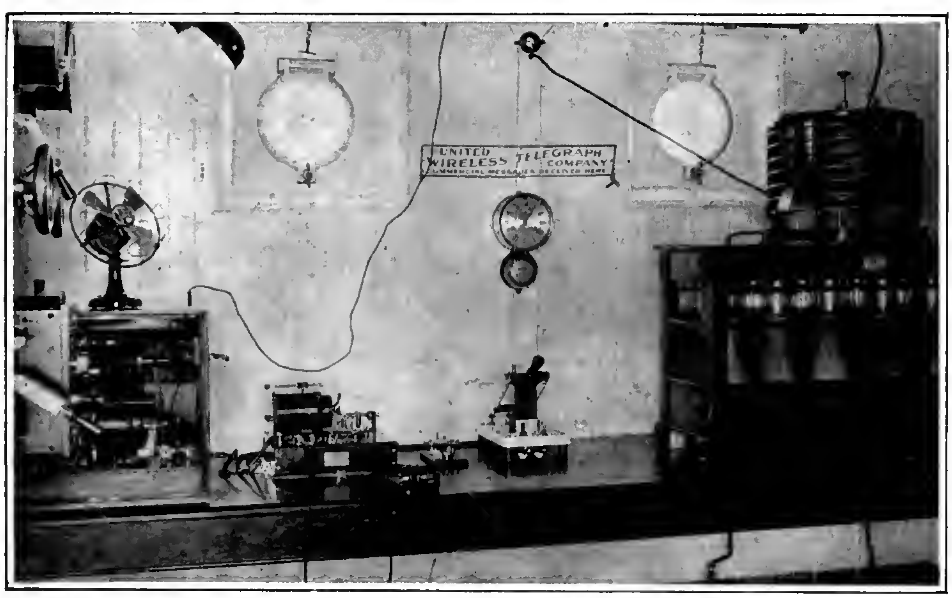
The start in wireless given to Mr. Baskerville by the De Forest Company led him far as an operator and practical man. The page reproduced here is from a circular of Dodge's Institute of Telegraphy and Wireless at Valparaiso, Indiana, where many radio men received training

When, with the key, he crashed that bare 2-kilowatt spark within two feet of me, certainly I missed nothing. On the contrary, I gained much! A steam siren, two fire engines, a fog horn and a couple of factory whistles all exploding at once will give you a shock similar to that which I got when that crashing open spark was let loose almost on top of my ear. I later learned that this was only a little joke of the smiling Birchard to impress upon greenhorn visitors that there was really something to this wireless after all. When he heartily laughed at his little piece of mischief, however, I pulled myself together and laughed with him, in a diplomatic way, for I had an axe to grind.

Leaving behind me this jargon of wireless terminology and still perhaps feeling a little unnerved from the effects of that inconsiderate 2-kilowatt spark, I again betook myself to the office of the general manager and made my report. Thereupon it was decided that I should spend all my leisure time in studying up this wireless system, while Mr. Galbraith promised that I should receive first consideration when an opening appeared in the construction gang.

During the ensuing weeks, I spent much time at the station, at the same time working my other job when the weather permitted. I became acquainted with such old timers as Lee De Forest, Henry Hughes, Jack Duffy, John Murphy, and many others who were in the wireless game right at the start, and who were constantly in and out the laboratory.

I entered thoroughly into the spirit of the wireless game and must even confess to bribery, so deep was my enthusiasm. To let me trace every inch of the wiring of the complete installation, I had to pay Birchard in pie and cigars. I had no idea at the



ONE OF THE TYPICAL SHIP WIRELESS INSTALLATIONS

Long before the days of the rotary spark gap, continuous waves, or vacuum tube wireless telephone and telegraph sets, outfits similar to this one were on use aboard ships. The shore stations had similar equipment, except that their power was about five kilowatts, whereas this installation is a 1-kw. one. The bank of condenser jars is shown on the table at the extreme right, the enclosed open spark gap inside the helix above it, and a lead connecting to an anchor spark gap to short-circuit the receiver while sending. The receiver was an inductively coupled crystal outfit, with a slider on the primary to vary the inductance. The emergency 10-inch spark coil is in the box at the left. It was operated from a 24-volt storage battery and was expected to transmit 100 miles in daytime

time what a gross offence this was on my part. Some time later, De Forest said to me of a man who had just been discharged, "Why, that man opened up the detector box and let curious people look into it." I afterward learned that the closest secrecy had to be maintained to prevent spies from other concerns learning our secrets.

SIGNS UP WITH DE FOREST COMPANY

On February 27, 1905 (again my diary informs me thus), I started to work for the De Forest Wireless Telegraph Company. My job was to help equip the S. S. *Caracas*, of the Red D Line. The salary was $15 weekly. I got more enjoyment out of that job than from any other and, I might as well admit it now, I would have been quite content to have worked for half the money I was given.

It was originally intended that the wireless equipment should be installed in the pilot house, but somebody advanced a theory about magnetic influence superinduced upon the compass. The debate between the ship's officers and John Murphy, one of the installers, was warm and enlightening, but eventually, to be safe, the set was put in a stateroom midships off the engine room—a nice noisy place, where the operator not only fought his natural handicaps, but also those wished upon him.

Our next job was the equipping of the Standard Oil tanker *Captain Lucas*, in the Erie Basin, Brooklyn, and after this, part of the construction gang and an operator were sent to Galilee, New Jersey, on March 3rd, 1905 to erect a station on the beach. It was not difficult to install the apparatus in the glassed-in front porch of Lockwood Cottage, but snow lay deep on the ground and a blizzard howled outside. The angry ocean creeping up our back yard rolled almost to the kitchen door, making it impossible to erect the 138-foot mast for the antenna.

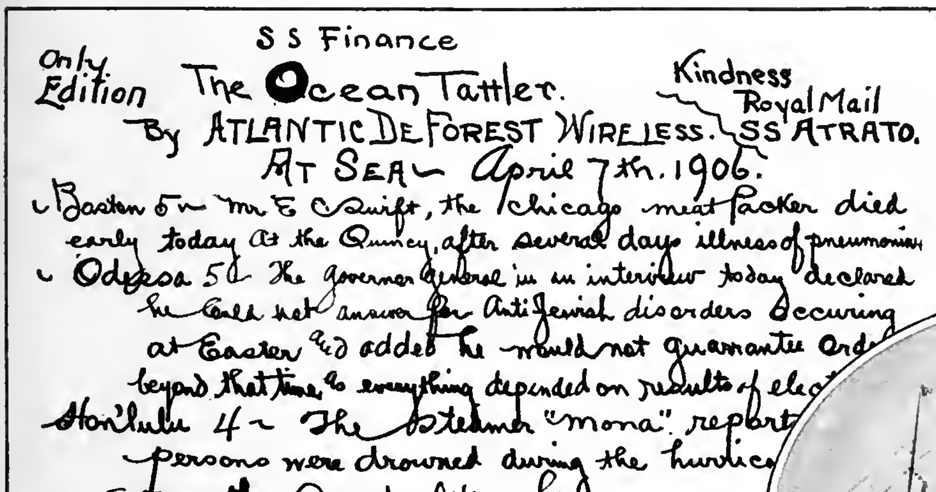
For several days we hugged the stove, ate Lockwood meals, and waited for the weather to moderate. The operator, Mr. Current, was recalled from Galilee. On the day of his departure, March 8th, during a lull of the storm, we got enough men together and hoisted the mast into place, an altogether unexpected accomplishment. Toward evening we had a complete wireless station ready for action but no operator. My diary says: "March 8. Galilee station finished. Sent first wireless message to New York at 7:22 P. M." This was one of the first stations ever to use a frequency above 60 cycles. We had 133-cycle supply from the local power house and our note was good.

While I belonged to the construction gang and didn't boast a first class telegraphic knowledge, I must modestly admit having at that time a little experience of telegraphy, for as a boy I often hung around the dispatchers' office on the Seaboard Air Line after school and "shot his stuff." Since taking up wireless, however, I had kept this knowledge to myself, but I listened-in whenever opportunity lent itself and could read signals providing they were clear and slow.

Now somebody had to put the Galilee station into service, and I felt that I was the one to do it now that the operator had been recalled. My fingers itched to get at the key and I finally succumbed to my desires. I christened the station just plain G, gave New York a few calls, and listened. Immediately came Birchard's GGG GA (go ahead) 3 NY. The figure three was the sign off signal.

I keyed out something to which Birchard replied O. K. wo? (meaning who are you?). I gave him the necessary information and added, "Not so fast, you old speed demon." He seemed very much surprised upon my identifying myself, and we carried on a long conversation. He picked and chose the little first-grade words, and that probably accounted for the success of my first experience as a wireless telegraph operator.

I felt very elated, and more so when, shortly after, New York sent a congratulatory message to me personally from "C. C.



S S Finance
Only Edition
The Ocean Tattler. Kindness Royal Mail
By Atlantic De Forest Wireless. SS Atrato.
At Sea April 7th. 1906.

Boston 5 — Mr. G. Swift, the Chicago meat packer died early today at the Quincy, after several days illness of pneumonia.

Odessa 5 — The governor general in an interview today declared he could not answer for Anti-Jewish disorders occurring at Easter and added he would not guarantee order beyond that time, as everything depended on results of elec…

Honolulu 4 — The Steamer "Mona" report… persons were drowned during the hurrica… recently swept over her.

Kingston, Jamaica 6 — We learn that a dec… by President Amador of Panama prohi… landing in Panama of Foreigners not… at least $17.00, unless they be under co… to work on the canal.

Seulu Natal Native Rising:
Durban Mch 16.— There is much irritation and impatience here at the disposition of certain home Politicians, as shown by cablegrams— to interfere in regard to the preventative measures against a possible spread of native disaffection in the colony. The press is making strenuous complaint against home interference, and a grave crisis unquestionably confronts Natal & South Africa. The whites are outnumbered 10 to 1 and there is a general fear that the natives will yield to his savage impulse for rapine, murder and destruction.

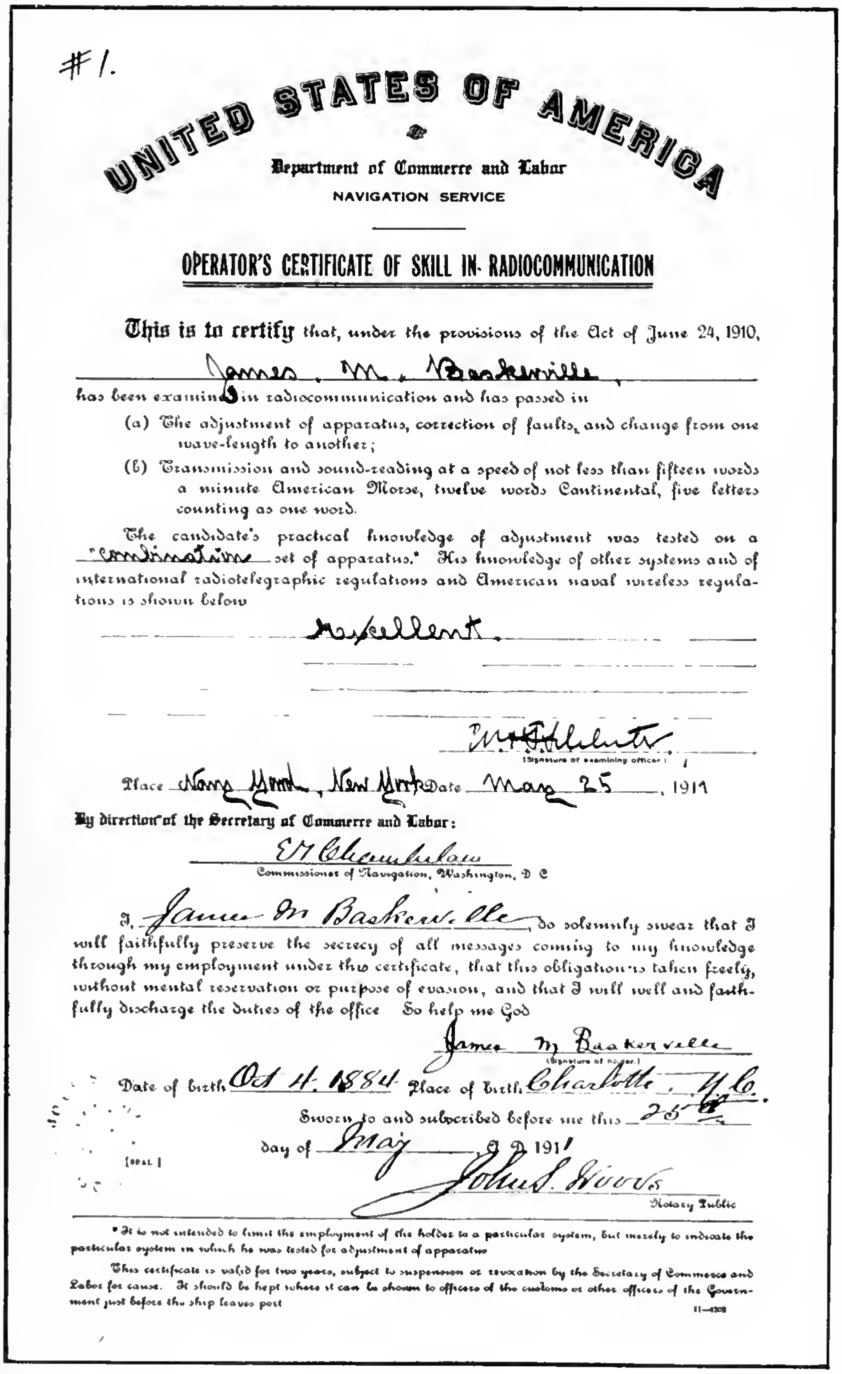
Editorial.
We are sorry not to be able to give more news, and especially U S news, but our means are limited, and we tender the foregoing for your perusal without a blush!

We are most pleased to note that Dr Leech has recovered from his recent seasickness

Vox Populi!

A DAILY "WIRELESS" NEWSPAPER

News the passengers aboard the Panama liner *Finance* received by the wireless set operated by Mr. Baskerville aboard this ship in April, 1906. The insert shows the Panama Railroad ship *Mexico* a vessel similar to the *Finance*, although several thousand tons larger. It is interesting to note that the news is as full of political difficulties as the paper you pick up this very morning



#1.

UNITED STATES OF AMERICA

Department of Commerce and Labor

NAVIGATION SERVICE

OPERATOR'S CERTIFICATE OF SKILL IN RADIOCOMMUNICATION

This is to certify that, under the provisions of the Act of June 24, 1910,

James M. Baskerville

has been examined in radiocommunication and has passed in

(a) The adjustment of apparatus, correction of faults, and change from one wave-length to another;

(b) Transmission and sound-reading at a speed of not less than fifteen words a minute American Morse, twelve words Continental, five letters counting as one word.

The candidate's practical knowledge of adjustment was tested on a "combination" set of apparatus.* His knowledge of other systems and of international radiotelegraphic regulations and American naval wireless regulations is shown below

Excellent.

(Signature of examining officer)

Place New York, New York Date May 25, 1911

By direction of the Secretary of Commerce and Labor:

E T Chamberlain
Commissioner of Navigation, Washington, D C

I, James M Baskerville, do solemnly swear that I will faithfully preserve the secrecy of all messages coming to my knowledge through my employment under this certificate, that this obligation is taken freely, without mental reservation or purpose of evasion, and that I will well and faithfully discharge the duties of the office So help me God

James M Baskerville
(Signature of holder.)

Date of birth Oct 4. 1884 Place of birth Charlotte, N.C.

Sworn to and subscribed before me this 25th day of May A. D. 1911

[SEAL]

John S. Hoover
Notary Public

* It is not intended to limit the employment of the holder to a particular system, but merely to indicate the particular system in which he was tested for adjustment of apparatus

This certificate is valid for two years, subject to suspension or revocation by the Secretary of Commerce and Labor for cause. It should be kept where it can be shown to officers of the customs or other officers of the Government just before the ship leaves port

11—4308

WIRELESS LICENSE NO. 1

In 1910, an Act to Regulate Radio Communication was passed by Congress and, in addition to specifying "certain ships" which were required to be equipped with wireless telegraphy, provision was made for examination and licensing of operators. The present-day licenses are granted by the Radio Service of the Department of Commerce and require a thorough examination of the applicant in the Continental code and in radio theory and practise

G." First I fumbled it and if I had not been very familiar with that name, I don't believe I would have gotten it so easily.

The following morning, Gregg, my companion at Galilee, received his traveling orders, but I received instructions to stay as operator! I regretted this keenly, and was sorry for my spontaneity of the night before. I remonstrated with "C. C. G." (who stood beside Birchard in New York), insisting that I belonged to the construction gang and couldn't telegraph. He said I was doing fine, and would I stay for the present. So I stayed. There was also a little salary adjustment—from $15. to $12., which probably came nearer to my real worth as a wireless operator. But while I had secured what I had orginally set out for—a change of job—the cold climate stayed with me.

Those days of being thrown entirely on my own had an effect similar to that of a boy thrown overboard and told to swim out. I copied—or tried to copy—everybody's business regardless of destination or speed, even to old Birchard when he unleashed himself upon New Haven, disregarding all speed limits, as his snappy rhythmic Morse chopped its way through Navy and Marconi interference. Up to this time my pace had been fairly rapid, but now, settled down at Galilee, I had time for reflection. I was the sole employee and therefore the guiding spirit of the station. I carefully watched day and night for any of our few ships which might be within range. Promised relief from New York seemed as far off as it ever had been, and it certainly was not a one-man job to keep a twenty-four hour station in constant operation. Finally, however, relief did come, in the person of A. W. Dorchester.

A few days after Dorchester's arrival, at 3.30 A. M. one morning, we logged the SS *Bermuda* two hundred miles out at sea. That was considered quite an accomplishment then. A few days later, we exceeded this feat of DX by thirty miles, when, under extremely bad atmospheric conditions, we handled business with the SS *Concho* 230 miles away. In this instance, each word had to be sent three times, so bad was the static. From that time on, we continued reaching out, using all the time an electrolytic detector with, of course, no amplification. We entered into the spirit of the thing with probably as much confidence as the owner of a modern multi-tube set. If there is to-day such a creature as the DX hound, we must assuredly have been the original DX pups, blazing the trail as forerunners of the International Radio Broadcast Tests.

My stay in Galilee was not long. It proved to be the first of a long series of short stays and quick jumps that I indulged in as I journeyed from place to place—from the Atlantic to the Pacific, from the Great Lakes to the Gulf. Contracts for ship installations began to swamp the construction people, and I was called in during April to help out. The *Horatio Hall* was being equipped down at the docks, and was scheduled to sail on a certain evening before she was out of the hands of the construction gang. It was imperative that the sailing date should not be delayed, so something had to be done at once. Superintendent Henry Hughes arrived at the dock in the nick of time, and without further ado informed me, "Finish the job and work her."

This was the first of many sea voyages I have made during my career as a wireless operator. It was, in fact, a turning point in my life, for it marked the time when I first definitely established myself as a fully fledged operator, after having deliberately broken into the wireless game.

THE RADIO URGE STILL LASTS

Mr. Baskerville, although he has long since left active radio work and is now in a very different business, is shown here with a Roberts Knockout receiver he built from plans printed in RADIO BROADCAST

THE MARCH OF RADIO

By J. H. Morecroft
Past President, Institute of Radio Engineers

Important Provisions of the New Radio Bill

RADIO legislation of importance, is now before Congress at this writing. The White Bill has been in the hands of the Merchant Marine and Fisheries Committee and that body has sent it to the House for consideration, where it passed on March 15, 218 to 124.

One of the new items added by the Committee provides that at least one broadcasting station in each state shall have a channel reserved for it. This assumes that Rhode Island has the right to a radio channel as much as New York. At present, of course, the available licenses have been granted on the basis of priority of demand; whatever state had the earliest and most insistent license seekers got the most channels. The wisdom of the "State's Rights" clause is not apparent on the surface. Few will deny that the apportioning of channels should be made in accordance with the best interest of most of the listeners and these interests have nothing to do with states' boundaries.

Another clause divides the United States into five radio zones, this idea also having to do with the allocation of the available channels. This item provides that

The photograph forming the heading for the March of Radio shows the receiving antennas at the British General Post Office, London, where commerical business is carried on with Continental stations. The dome of St. Paul's Cathedral is in the background

In considering application for licenses and renewals of licenses when and in so far as there is a demand for the same, the Secretary of Commerce shall make an equitable distribution of licenses, bands of frequency or wavelength, and power among the different zones.

The first zone is to embrace the New England states, New York, New Jersey, Delaware, Maryland, District of Columbia, Porto Rico, and the Virgin Islands. The second zone contains Pennsylvania, Virginia, West Virginia, Ohio, Michigan, Kentucky, etc. It is not at all evident that this division of the country into zones will have any considerable merit. It is certainly not to be expected that each zone should have the same number of channels allotted to it. The density of population is entirely different in these districts so that equal treatment as regards number of channels would not be equitable. The Secretary of Commerce would naturally apportion the licenses equitably between the various parts of the country even under the present condition. The zoning plan would be of no help to the Department.

An added feature, however, of this zoning clause has to do with the appointment of the commission. A commission of five members is to be appointed, one from each zone, to constitute an advisory body to aid the Secretary in the apportionment of channels. These additions to the original White Bill, will probably do it no real harm, though it certainly is questionable that the Bill has been improved.

Groundless Fears About Poor Reception

AN IMMEDIATE investigation should be undertaken by the government to determine the cause of unusually poor radio reception throughout the country. This is the opinion of many listeners who are racking their brains to find some scientific theory to explain existing receiving conditions.

During the past month radio reception has been remarkably poor, in the opinion of some listeners. We hadn't noticed it because long ago the distance craze left us. The broadcasting from local stations is not subject to weather conditions. Ideal reception should not be subject to weather conditions. Our compassion goes out to those who complain that "reception was poor last night." One's enjoyment of a good radio program shouldn't be at all dependent on static or other disturbing influences.

Apparently listeners in Washington and vicinity have encountered more than usual

A BRITISH MARCONI RECEIVER

The type RG5 general utility set, comprising detector, audio amplifier, antenna tuning circuit unit and closed circuit tuning unit. It is designed to meet the requirements of those who need an efficient and selective receiver to cover a very wide range of frequencies, 1000 to 10 kc. (300-30,000 meters)

difficulty in hearing Northern and Eastern stations, and so have started the move to have the government investigate these atmospheric disturbances, perhaps with the hope that this attention from the government will prevent another such poor receiving cycle.

There have been some abnormally large disturbances on the sun lately and as it is now believed that sun spots are accompanied by the violent expulsion of tremendous clouds of electrons, it seems most likely that the earth did run into exceptionally bad electrical disturbances during the past month. The electrons in the upper atmosphere are credited with most of the abnormal behavior of radio waves and in fact when one takes these clouds of electrons into account that which we have heretofore considered as abnormal behavior seems reasonable and almost predictable. Fading and skip distances seem to be surely due to reflections from the electron-charged atmosphere a hundred or more miles up.

When extra electrons are shot off from the sun, our radio channels may be somewhat affected, but in spite of this fact it will probably do little good to have the Federal agencies investigate them. Radio transmission will always be subject to vagaries to some extent, as are the mariner's compass and the ocean cable. In periods when extensive sun spots occur, both the earth's magnetic field and the stray currents in the earth's crust are subject to rapid and irregular changes. It is not remarkable that radio transmission also shows sympathetic reaction with the sun.

The heads of the Radio Department of the Bureau of Standards and Chief Radio Inspector Terrell, have both been asked to conduct an examination. Both of these busy men, however, have their hands full in doing their present specified work without taking on a new and indefinite problem of this nature. It looks as if we had better accustom ourselves to taking radio weather as it comes, exactly as we do the common variety of weather.

Four Hundred and Twenty Eight Broadcast Licenses Refused

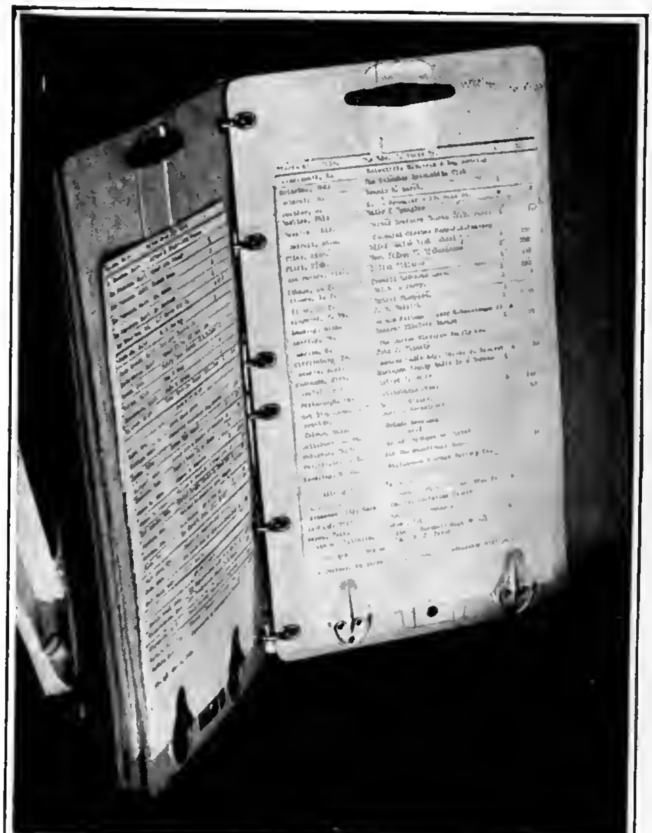
WITH five hundred and thirty-six stations actually broadcasting in the United States, there are four hundred and twenty-eight more anxious to serve the listening public. For some time now, we are glad to say, no new licenses have been issued by the Department of Commerce, so that the congestion, which a year ago was increasing in leaps and bounds, has become constant.

At the last radio conference, the conferees apparently convinced the Secretary of Commerce, that the public wanted him to stop issuing licenses. Mr. Hoover has heeded the call. But the fact that no new licenses were being issued didn't at all deter the aspirants for radio channels. Each day brings appeals for permission to broadcast. Few of these will, or can, be satisfied unless the present broadcast band is extended, so it behooves the desirous ones not to invest too much money in their prospective stations.

Two of the applicants would use five thousand watts, one three thousand five hundred, one fifteen hundred, and eighteen want permission to put up one thousand-watt stations. Besides these expectant newcomers there are thirty-three of the present stations making requests for permission to increase their power.

Of the various radio districts, the Ninth, centering in Chicago, heads the list with requests for new stations totalling a hundred and forty-seven. Chicago alone would have nineteen new stations if every potential broadcaster had his desires fulfilled! Other districts do not seem to be afflicted with as strong a desire to "tell the world" as the Mid-Western ones. The Second district wants only twenty-five new stations although New York is included. The southeastern district wants forty-eight new stations, most of them the extreme South, perhaps to boom Florida real estate. The northwestern district wants fourteen new channels, the southern district thirty-nine, the eastern, including Philadelphia, wants seventeen, and the Detroit district wants forty-one, as does the western district, including California.

It seems almost certain that these new licenses will never be issued. There is no equitable way to substitute new applicants for some of the present incumbents. If the station at present occupying a wavelength is fulfilling its obligations, why should it be forced to divide time or go off the air in favor of some other station, now demanding a license? The wisest move for the prospective broadcasters would be to first ask themselves if the material they have to dispense is worth while and if it is, to get in touch with some existing broadcasting station. By engaging a going station for a few hours a week, the reasonable needs of a new broadcaster would be satisfied and the programs of the stations used probably improved in quality. Furthermore, the prospective station owner would probably save himself a lot of money.



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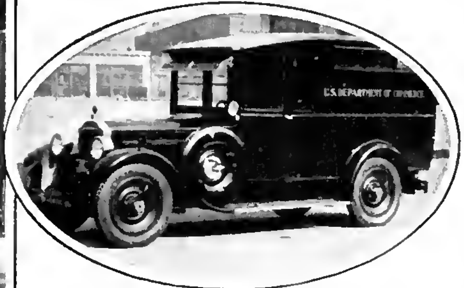
THE BOOK OF REGRETS

Applications for broadcasting licenses are recorded in this book, in the offices of the Department of Commerce at Washington. Up to March 1, 1926, the list totalled 428 applications, none of which have been granted because there are no more wavelengths left. Applications come from 45 states and the District of Columbia. Illinois leads with 47 who request a license, California is second with 40, and New York third with 28. The right hand page shows that The Columbus Automobile Club has applied, the Polish Alliance at Hamtramck, Michigan, the Toledo *News-Bee*, the Pittsburgh *Press*, and many churches and civic organizations

THE INTERFERENCE CAR



Packard Motor Company photographs

Equipped by the Radio Service, Department of Commerce, and at present attached to the Eighth District, with headquarters at Detroit. Complete trouble-finding apparatus is installed and many cases of interference have been tracked down with it. Lack of funds has prevented the building of similar cars for the other seven districts

Interference Eliminating Is a Local Matter

WITH improving quality of broadcasting, both programs and transmission, the nuisance from interfering noises of one kind and another becomes ever more noticeable. In the old days of Frank Conrad's phonograph concerts at East Pittsburgh (beyond the ken of most of to-day's listeners) the sputtering of a defective street car motor or humming of an electric elevator detracted but little from the quality of radiophone reception. The interference was nearly on the same level as the program itself, judged by musical values. But nowadays with high class transmitters, receivers, and loud speakers, and artists of the highest calibre, performing over the radio channels, the clicks and hisses and sputterings and squeals become downright objectionable. The public's appreciation of modern radio is such that no effort should be spared in clearing the air of objectionable interference.

The best way to eliminate interference from the railway or electric power company is to induce the president thereof to become a radio enthusiast. The best way to eradicate the whistling from a neighbor's regenerative set is to invite a member of that family to dinner with you, turn on the dinner music and let him hear his home set perform in the hands of the other part of the family. But there are many sources of interference where such strictly humanistic methods of attack are not available. Many sources of radio noise conceal themselves, so that only a methodical search will find them out and of course they must be found out before they can be eliminated. This "finding out" is apparently the *raison d'être* for the many interference committees springing up all over the country. Many listeners believe the radio department of the government should come to their aid, ferret out and eliminate the causes of radio interference. What else is the Radio Service for?

The government's radio personnel was organized many years ago to supervise ship and shore traffic. With the tremendous increase in breadth and scope of radio communication within the last few years, the relative size of the government's radio staff has become almost insignificant. They do a vast amount of work in trying to keep up with their tasks, but it is manifestly impossible for them to take on the entire burden of interference prevention.

Local radio clubs must assume the task of eliminating interference in their neighborhoods and this is the solution which seems to be working itself out. We hear of many such clubs, and of their general success. Unless the interference is of the most persistent kind which does not give way to persuasion, the radio inspector should not be bothered with it at all; it really isn't his task.

Transatlantic Telephoning Is Progressing

THREE years ago we had occasion to congratulate the engineers of the A. T. &. T. Company for establishing a radio telephone channel which spanned the Atlantic. With a transmitting outfit set up at the Rocky Point station of the Radio Corporation and a receiving outfit in England, reasonably successful telephony was carried across the Atlantic one way. Many measurements were made on signal strength, and the average of strength of atmospheric noises in England, so that engineering data was obtained as to how much power must be used in the transmitting antenna to get across a signal which is readily distinguishable over the noise. Thousands of measurements were made so that the American engineers were able to say that, with average atmospheric conditions in England, for reliable communication throughout, say, sixteen hours of the day, the power used in America must be a certain number of kilowatts.

To be sure, eight years previously, these same engineers had achieved a much more remarkable result in telephoning from Washington to the west coast and to Honolulu. This feat, however, must be reckoned to some extent as accidental; the God of Progress was kind to the young engineers in rewarding their imagination and bold attempts. That was much more spectacular than the work of three years ago, but it is this more recent accomplishment that makes for engineering knowledge and advancement. The Honolulu miracle showed what was possible and it furnished the motif for the later arduous and difficult task of reducing the accidental to a certainty.

These tests three years ago brought out clearly the difficulties of spanning the Atlantic, but the difficulties were not insurmountable. The work was sufficiently promising for the British authorities to be encouraged to build a powerful transmitter at Rugby. The receiving station was set up near Swindon.

During the last two months the transmitters and receivers in both England and America have been at work, and on many occasions successful two-way conversations have been held. "The quality of speech in both directions was clear and free from distortion or fading and the voices of individual speakers were easily recognizable." So reads a report from London. Certainly no one need say that the age of miracles is over.

Behind the report of a successful test of this kind, one who knows sees days and nights of strenuous application by many able young engineers. When the test is made the President of the A. T. & T. Company talks perhaps to the British Postmaster General and they, as heads of their respective bodies, are lauded for the achievement. Well, really, they have had a

DAME NELLIE MELBA

Australia; In a farewell message given to the London press

"Amid the sadness of bidding good-bye to so many good friends of mine up and down the country, it has been a pleasure to note almost everywhere a quickening in musical appreciation. To-day there are gratifying signs that the British audience begins to hear as well as listen.

Mainly, so it seems to me, the secret of this new interest is to be found in the astonishing enlargement of the audience for music accomplished by the gramophone and broadcasting. Although I believe I was the first prima donna to make a gramophone record and the first to broadcast, I have not, whilst recognizing the possibilities of these devices, ever accepted either of them uncritically, and I am well aware of the flaws in wireless as that science is practised to-day. But, just as I I have followed the gradual perfecting of the gramophone, so I think one may look forward to like improvements in wireless. Broadcasting and the gramophone are certainly the two most eloquent missionaries to the musical heathen in our midst."

very minor part to play. All these eminent gentlemen have to do is to exercise their imaginations sufficiently to see that the task is worth while, that the attempt is sufficiently promising to consitute a proper outlay of funds. Then after they have approved the program, it is the visionary, yet practical, engineers that complete the work. Many of them there are whose names are never mentioned, who have worked the night long to improve this piece of apparatus, to discover the trouble with that piece, to develop schemes for measuring and a thousand other developments on which an achievement of this kind rests. So homage we pay to the young engineers who remain in the background. On March 7, 1926, this channel remained open both ways for more than four hours. Many people on both sides of the water were able to use it with the same ease they do their ordinary telephones although a special high quality microphone was used in New York on these tests and so good was the transmission that voices on either side the ocean were clearly recognized.

The Radio Corporation's Annual Report

THE annual report of the Radio Corporation makes very interesting reading to any one following the progress of radio.

The Corporation now has high-powered stations in the United States communicating directly with Hawaii and Japan, Dutch East Indies, Great Britain, Norway, Germany, France, Holland, Italy, Poland, Argentine, and Sweden. Such a network may well be styled world-wide. Early in 1926 Brazil will be added to the above list, as the transmitting and receiving stations at Rio de Janeiro are nearly completed. This station is being constructed, not alone by R. C. A. but by an international company designated as A E F G. These letters stand for America, England, France and Germany, we take it, because these four countries have united in developing South America's radio channels.

All of the marine stations of the Corporation have now been equipped with the latest types of vacuum tube transmitters. These are located at Chatham, Massachusetts, New York, Tuckerton, New Jersey, Galveston, San Francisco, and Los Angeles. At Chatham the power has been much increased by diverting to it some of the power generated by the great Alexanderson alternator at Marion, and using it in the higher frequency tube transmitter.

The report states

> A radio direction finder was developed and placed on the market. This device so demonstrated its value as an aid to navigation that your corporation received the largest single order ever placed by a shipping concern for direction finders.

Reference is made to the development of short-wave transmitters for long distance communication, but "this system," we learn, "while a useful supplement to your Corporation's long-wave, high-powered transmitters, is still regarded as in the experimental stage." This idea of short-wave, low-powered transmitters was only recently hailed by the Naval Radio Laboratories, it will be remembered, as spelling the doom of the present powerful transoceanic stations using very long waves.

Attention is called to the reduction in the price of radiotrons during the past year, namely, from four dollars to three dollars and then from three dollars to two fifty.

The research and development staff of the Corporation have been spending their efforts, "to increase the efficiency and per-

A RADIO COMPASS INSTALLATION ON A GREAT LAKES SHIP

The *J. A. Campbell* being equipped with a Radio Corporation radio compass at a dock in Toledo, Ohio. The left hand illustration shows the loop atop the pilot house and the other view shows the receiving equipment inside, with the indicator and wheel for adjusting the loop. Head telephones are used and the loop adjusted so that signals are loudest and then the reading on the indicator noted. Forty ships on the Great Lakes are being equipped with this new protection for life at sea formance of radio receiving equipment and to develop its broadcasting facilities and thus further contribute to the service upon which the industry is built."

Reference is made to the opening performances of the high-powered station at Bound Brook and it is stated that the daylight range of this station is about five hundred miles, and during the night it has been heard practically everywhere in the United States. The report states that comparatively few complaints were made by persons living in the immediate vicinity of Bound Brook that the operation of the new station interfered with their reception of other stations. There is no reference in the report to the action of municipal and state bodies seeking injunctions against the station. Intelligent work by the engineering staff of R. C. A. in actually helping the complainants to cut out the powerful signals should smooth over what looked like a radio tempest brewing around Bound Brook.

The essentially patent-holding character of the Radio Corporation is shown by the financial statement. Material assets in transoceanic stations, ship stations, broadcasting stations, etc., total less than $14,000,000 investment, while the patent and good-will items in the assets column call for approximately $16,000,000. An interesting entry in the liabilities statement is "Good-will written down" for $1,500,000. Most of us would be glad to sacrifice quite a bit of good-will for that tidy sum. The net income for the past year was $5,737,206.15, a decrease of about two million from the corresponding figure for the previous year.

The Importance of the Aurora

A RECENT display of Aurora Borealis stirred up again a discussion as to what effect this natural display of northern electrical disturbance has on radio transmission. We believe now that these northern lights are due to clouds of electrons shot off from the sun, causing ionization in the rare upper atmosphere, and possibly affected somewhat by the earth's magnetic field. Certain it is that the Aurora is generally accompanied by very large disturbing currents on the earth's surface, as ocean cables and many telegraph lines which use the earth as a return path are frequently put out of commission for many hours by these wandering currents. During the recent display of Aurora, some telegraph lines reported voltages, due to stray earth currents, as high as one hundred and fifty.

These effects, however, seem to be of such a low frequency, that we hear nothing of them in radio reception. One man who ought to know, better than any other, about the effect of northern lights on radio transmission is Donald MacMillan. He has gone right under the Aurora display, so that they became for him southern lights instead of northern lights, yet he says they have no effect on static.

Probably the electrical condition of that part of the atmosphere where the Aurora disports itself has a great deal to do with radio transmission, but this condition affects radio whether the Aurora appears or not. The Aurora may be, in so far as radio is concerned, merely an indication that the Heaviside layer is there.

The Month In Radio

WHY don't you tell us what kind of radio reception we are going to have tomorrow night? asks Gentle Inquirer, of Prof. C. F. Marvin, Chief of the United States Weather Bureau. Many times requests are made of the Bureau, says Professor Marvin, for a radio weather forecast.

It may well be that radio conditions and weather conditions have some very close connection. Several observers (see J. C. Jensen's article, RADIO BROADCAST for March) have tried to find just what the association is, but the problem is big and the work so far is not entirely conclusive. It is a fertile and fruitful field for investigation. Much interest has been aroused by Mr. Jensen's article which gave the results of experiments made over a period of several years.

A RECENT announcement reported that an inventor of Chicago, L. W. Skala, had accomplished what we had heretofore regarded as unfeasible, the transmission from the same antenna of several messages on the same frequency, which could be unscrambled in a receiver. Ever since Mr. Grindell Mathews announced his "death ray" and failed to make good, however, we have a tendency to claim residence in Missouri and wait to be shown. Far be it from any one with imagination to regard a radio feat of this sort as impossible, but it pays to be slow in becoming enthusiastic, for there are so many inventions that fail to work as the inventor claims.

Dr. A. N. Goldsmith, chief broadcast engineer of the R. C. A. said of Skala's announcement:

Radio listeners and engineers are interested in a method that proposes to reduce the present amount of interference between broadcasting stations. However, until they have full details from scientific publications or issued patents, they cannot well give any decision as to the value of any particular device. In order for a system for simultaneous transmission on the same wavelength without interfering to be useful, it must meet two requirements. The first is that two transmissions will not occupy more than the usual ten-kilocycle band which is used by ordinary broadcasting stations to-day and the second is that the receiving equipment shall be such that it can readily be used by the average broadcast listener.

THERE is apparently a move on foot in the Canadian Parliament which has all the flavor of being sponsored by our friends the A. S. A. C. & P. and radio fans and theater managers are up in arms against it. A bill is being fathered by L. G. Ladner, M. P., Vancouver, which aims to amend the copyright law of the Dominion in such a way that radio and theaters might be subjected to unreasonable and indefinite royalty demands. According to accounts in the press, the Montreal Theater Managers Association feel they run the risk of being victims of extortioners, who may ask so much royalty under the permission to be granted by this bill as to ruin the theater business. A similar association is being planned in Ottawa, and both societies, helped by the radio managers, will apparently conduct a vigorous campaign against this change in the present copyright arrangement.

DR. A. HOYT TAYLOR

Washington: Chief of United States Naval Research Laboratory

"It would appear from theoretical considerations that waves much shorter than 14 meters will not be of much use for really long distance work. Even in the band between 20 and 40 meters, a phenomenon occurs which we call the skip distance effect.

Under certain conditions, when operating in this band, stations at relatively near-by points, will be skipped over or missed entirely, whereas very intense signals will be received much farther on. This effect naturally was very puzzling before it was understood.

I can recall an occasion when I was in communication on the 20-meter band with a British station between 12 and 1 in the afternoon. At the same time, two American amateurs, one in St. Paul, Minnesota, and one in Connecticut, were listening-in for the test. The only way I could communicate with the man in Connecticut was to relay a message either through St. Paul or through London. He was unable to hear my signals, and I was unable to hear his. On the other hand, I was perfectly well able to work London. The St. Paul man, being outside the skip distance, which at that time of the year was about 600 miles for that wave, was able to communicate with both stations."

Interesting Things Said Interestingly

W. SETON GORDON (London; in a letter to the New York *Times*): "Speeches broadcast by the British Broadcasting Company at public dinners, take well. The wireless fan soon gets to recognize and distinguish the voices of all public men. It is something worth while to listen to the actual voices of elder statesmen and to men who, in every department of public life, have done things and made history. At important ceremonies the King's voice is heard. He is a ready speaker.

Shall I Buy a Factory-Built Receiver?

The "Bought Set" Is Coming Into Its Own—Experimental Work Done in the Manufacturer's Laboratory and Not in the Buyer's Home—Simplified Wiring and Assembly Have Reduced Production Costs Without Impairing Quality—More and More Substantial Values for Buyers

By AUSTIN C. LESCARBOURA

DURING the past two years, radio receivers have come out of the trick circuit period and manufacturing has developed on an entirely different basis. We have not yet reached the ultimate in circuit efficiency, to be sure, but we have learned to produce receivers at fairly low prices which are extremely satisfactory. So far as the layman, on pleasure bent, is concerned, he has little to worry about in the purchase of a receiver. Most of those now offered by reliable dealers—except the bargain mark-downs, yet even some of these may be included—are good. The extent of their goodness is, as a general rule, dependent upon nothing but price.

Now the editors of Radio Broadcast *cannot, in fairness to all, get down to a series of descriptions of individual receivers. We cannot take up valuable space with a detailed discussion of the operation and performance of a given receiver, since that very matter is amply covered by the manufacturer in his printed matter. But we can and, beginning with this article we shall present the trends and tendencies in radio receivers from time to time. Articles such as "What's New in Radio" (January, 1926,* Radio Broadcast*) written by Austin C. Lescarboura, formerly Managing Editor of the* Scientific American *and author of the book, "Radio for Everybody," are, we feel more satisfactory. We shall publish similar articles from time to time, as the material becomes available. And so we offer at this time the first of a series on the trends and tendencies of radio receivers.*—The Editor.

THE conveyor belt moves along at the leisurely pace of three feet in one minute and ten seconds. At one end, a girl places a bare metal frame between each pair of cleats on the moving belt. At the other end, some two hundred feet down, a gantlet of busy hands and buzzing voices, another girl inspects the assembly, touched a joint here and there to flick off surplus solder, and initials a bright red ticket that carries the pedigree of a radio receiver just born into the broadcast world. So, in an hour's time, a multiplicity of odd parts have grown into an elaborate assembly called a radio receiver, with every last wire soldered in its proper place; with every adjustment carefully made, and with a thorough check on the wiring and the workmanship involved.

Typical of the manufactured radio receiver of to-day is this scene in a plant which turns out six hundred receivers each working day—receivers of the most elaborate type. In another part of the same plant the various radio components are manufactured in a similar efficient manner. Each component, as it is completed, is provided with its individual wiring in the form of flexible leads cut to predetermined length and with the free ends skinned and tinned, ready to be connected in their proper electrical position in the final assembly. And even the parts that go to make the radio components—screws, nuts, moulded pieces, punchings, and so on—are likewise produced in this vast self-contained radio plant. Is it any wonder, therefore, that some manufactured receivers can be sold at prices for which the parts themselves could not be bought by the home constructor?

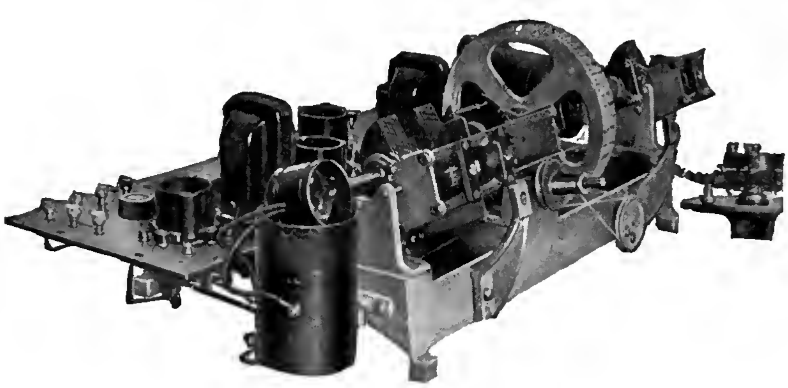
How an intricate piece of apparatus like a radio receiver is reduced to a quantity production problem, is a long, long story. It starts in the laboratory of the conscientious manufacturer, where real radio engineers and indefatigable research workers are constantly engaged in working out new circuits and variations of old circuits. Set-up follows set-up. Test follows test. Out of a maze of radio components sprawled all over the laboratory table, and entangled in a veritable web of loose wires, there evolves a circuit which in the opinion of the laboratory staff and production staff alike—not forgetting the patent attorney—combines the necessary radio qualities with the refinements called for in manufacturing on a vast—and safe—scale.

After all, radio manufacturers to-day are agreed that the place for experimenting, so far as the manufactured radio receiver is concerned, is in the laboratory. The average purchaser of a manufactured radio receiver is not seeking a collection of experimental apparatus which may have to be arranged and re-arranged, added to and subtracted from, in order to secure the desired results, but a finished product which, with minimum effort, will satisfactorily bring in radio programs. The receiver is generally looked upon as a necessary evil by the average radio listener.

So with all leading radio manufacturers, a radio receiver begins its career back in the research laboratory, where the circuit is finally evolved. Then follow the mechanical considerations. Various arrangements of parts are assembled and tested until the receiver takes definite shape. Then comes the bench model, which is virtually the prototype of the final receiver, even to the cabinet and panel engraving and finish. The bench model is an animated blueprint, so to speak. It must be passed on by the engineering staff, the production staff, the sales staff, and, in some instances, certain representatives of the public, who judge the contemplated offering. Bench models cost fortunes; indeed, a king's ransom would not suffice to purchase some bench models of well-known radio receivers. It is said that the first bench model of the well-known super-heterodyne receiver cost well over a million dollars to produce! But fortunately, radio receivers do not stop at the bench model stage.

At any rate, the bench model is eventually okayed, following which it is turned over to the tender mercies of the production staff whose task is to make thousands and tens of thousands of copies at a cost within reach of all radio fans.

The bench model is literally torn apart, piece by piece, while production engineers analyze each piece that enters into the whole, even to the last screw and nut. In some instances, certain changes must be made to conform with production methods. Blueprints and specifications are prepared in great detail. Indeed, we have seen specifications for a well-known receiver, which were in the form of fourteen voluminous books and packets of blueprints. Even the cabinet of this receiver was covered by a specification book, stating the kind of wood to be used, how it should be dried, the finish and how it could be secured, the hardware, the glue, and so on. Every part, even to the modest washer, receives a number in the specification, for ready reference. Likewise with the wiring. Each wire is given a number and differentiating feature, such as a certain length, or colored braid.



THE MECHANISM OF THE FERGUSON EIGHT

A remarkably efficient single-control receiver. The complete unit is mounted on a rigid aluminum frame, similar to an automobile chassis. There are three variable condensers tuning the grid circuits of the two radio frequency tubes and of the detector tube. Three stages of matched audio frequency amplification are incorporated in this circuit. A revolving drum is marked off in five-meter units, and is synchronised to turn in coöperation with the condensers

And now for the multiplication process! The plant is arranged for the detail manufacture of the various components, in the case of the largest manufacturers, while in other instances contracts are placed with radio parts manufacturers. In the former event, suitable dies and moulds must be prepared. The detail manufacture arranged for, either within the organization or with outside coöperation, the progressive assembly process is now considered. Radio manufacture, these days, is generally a matter of having small parts grow into important parts, important parts into sections or sub-assemblies, and these sections or sub-assemblies into the complete receiver.

Progressive assembly calls for marked organization ability. The steps must be planned so that the work will flow in the same easy manner as water flowing from the mountains to the sea, steadily increasing in volume from stage to stage. Jigs and fixtures must be designed and provided so that the girl workers can do their respective work in just one way—the right way. This ensures uniform workmanship. Following the installation of the necessary machinery, tables, chairs, help, must be secured. Materials must be ordered.

THE BREMER-TULLY COUNTERPHASE SIX

Here is a receiver which employs three stages of radio-frequency amplification and yet there are only two main controls. A special method of oscillation control is incorporated in this set. The panel is of copper, this feature tending to increase selectivity and reduce stray noises

Then, at last, production starts, with engineers coaching the workers in their respective tasks. Certain changes may be made to meet unexpected conditions. Veritable bottle-necks appear—stages in the work which require more time and labor than was originally anticipated—and certain re-arrangements may have to be made. But finally, the radio receivers begin to pour out of the factory, with the precision of clockwork. The costly bench model is now excelled by the manufactured receiver which is offered at a price within the reach of all. How simple it all seems!

SIMPLICITY THE KEYNOTE OF EFFICIENCY

PROGRESSIVE assembly, as already described, makes for volume production which, of necessity, makes for low individual cost. Then, too, instead of employing skilled radio technicians for the assembly and wiring of each receiver, the work is ingeniously planned for girl workers, who, strange as it may seem, usually do not know the first thing about radio—and care even less! Girl No. 39 knows that her job is to mount jack type 3-H in the left hole of the sub-panel. Girl No. 62 is responsible for mounting condenser type C-4 in its alloted position. Girl No. 83 wields a soldering iron, seeing to it that wire No. 56, plain black, 6¼ inches, with free end already skinned and tinned, is brought over to the third connecting lug on the terminal strip. And so it goes Each girl has one duty to preform. She does it to her own satisfaction and that of the critical inspector.

There is a vast contrast between the manufactured receivers of to-day and those of yesteryear. The elaborate bus bar wiring so much in vogue in the manufactured as well as the home-built radio receiver, is becoming less and less evident in the manufactured offerings. Instead, the wiring is handled with flexible and insulated wires, as well as connecting cables. Truth to tell, the receiver mechanism does not present the neat appearance of former days, but from a purely radio standpoint the results are better than ever, so why worry!

In some instances the wiring is accomplished by means of thin strips of metal, which are actually eyeletted to the various parts joined together. Here is a method which saves a vast amount of time yet serves just as well as the most elaborate bus bar job handled by an expert radio worker.

And what has been done by way of simplifying the wiring is likewise in evidence when it comes to other details. One well-known make of receiver, for instance, employs variable condensers which, at first glance, would seem altogether too crude to do their appointed work. There is virtually no finish to these components. In fact, these condensers, as we see them unmounted on the bench, even lack tension or balance so as to make the rotor plates "stay put" in any position. Still, these very same condensers, in combination with the unique drum controls provided with friction brakes, provide one of the most selective and efficient tuners now available.

So it goes. The trend and tendency in radio manufacturing to-day is to make the receivers as simple as possible, consistent with the best radio results. No end of money and effort is put into the development of circuits and the combination of ideal components; but, on the other hand, if something can be simplified, if the wiring can be reduced, if a part can be eliminated or at least replaced by a less intricate and less costly part without sacrificing the quality of performance, it is done. After all the radio buyer should be interested in what issues from the loudspeaker, first, last and always. He is buying a seat in the radio broadcast auditorium, and it is up to the radio manufacturer who has sold the ticket in the form of the radio receiver, to make sure that the radio "fan" gets a good seat.

FLIVVERS AND ROLLS-ROYCES OF RADIO

ALL OF this may be a rather long way of coming down to the simple thought that radio receivers can be produced at surprisingly low cost. Thus we have five-tube receivers now offered at prices even lower than the cost of the one-tube receivers of the early days of broadcasting. The quantity methods already mentioned, together with simplified mechanics and wiring, have made possible these really good receivers offered at prices within the reach of the modest pocketbook. The fan who could afford nothing better than a crystal detector set in 1921, now gets at least a three-tube receiver of infinitely greater value.

All manufactured receivers to-day, with but very few exceptions, are good. After five years of highly competitive effort, radio manufacturing has come down to a plain question of the survival of the fittest, so that manufacturers of radio junk have, for the major part, passed out of the picture. Those still remaining among us are rapidly mending their ways or, like the proverbial Arab, getting ready to fold their tents and disappear in the blackness of the night lest they be scalped or suffer whatever fate comes to the dishonest radio man at the hands of an outraged public.

So the problem of selecting a radio receiver to-day is no longer what it was a year or two ago. As a general rule, all manufactured sets to-day may be considered good. True, the advertising claims at times may be somewhat enthusiastic, but then, it should be remembered that the battle of superlatives has been going on since the advent of radio broadcasting. The goodness of a radio receiver, irrespective of the glowing tributes of the manufacturer himself, can generally be taken for granted.

The relative degree of goodness, on the other hand, is a quantitative proposition and therefore more difficult to estimate. However, it is a safe and sane rule to judge relative goodness by the selling price. Values are now fairly well standardized on all types of radio receivers, so that a given sum will buy just so much radio receiver and furniture. Occasionally

GLORIFYING THE AMERICAN CABINET MAKER

This is a Kennedy Spanish Desk receiver. There is no denying the fact that it would enhance the appearance of almost any room in which it might be placed. The cabinet is finished in either mahogany or American walnut

A BRITISH DELUXE RECEIVER

This is a fine example of British workmanship, comparing favorably with the American sets illustrated on these pages. It is manufactured in Manchester, England, by the Metropolitan Vickers Company

the buyer will get a greater proportion of furniture, or ornate cabinet, than the radio feature. Furniture, like radio, costs money, and a given selling price will stretch over just so much of each. Too much of one may mean too little of the other, at a given price.

All in all, the price is a safe criterion, provided we are considering the offerings of established and reputable manufacturers.

Remarkable progress has been made in the way of multi-tube receivers selling at surprisingly low prices. There are now many makes of five-tube sets, with two stages of r. f., a detector, and two of a. f., selling at prices within the reach of the modest pocketbook. The average inexpensive radio receiver of this kind, which costs less than $100 complete with batteries, loud speaker, vacuum tubes and installation, will provide satisfactory radio entertainment. Like the flivver of the highway, it serves the plain purpose intended; but it is useless to compare the performance with that of the radio Rolls-Royce. Both receive radio programs—but a noticeable difference in tone quality between the low-priced and high-priced radio offerings is generally apparent. The low-priced radio receiver, generally speaking, cannot operate a high-grade cone speaker with satisfactory results. Obviously, expensive transformers or other means of quality amplification cannot be included in a receiver which costs little more than the ingredients of such amplification. Again, the inexpensive radio receiver is limited to the simplest form of tuning mechanism—simplest from the manufacturing standpoint, but likewise the most complicated from the operating standpoint. The three-dial method of control is usually standard on low-priced five-tube receivers, since it is the cheapest to make. Then the components of the low-priced receiver must of necessity be plain, devoid of the refinements and precision found in the more expensive receivers. This, of course, is reflected in the performance. Still, it is gratifying to find the latest type of variable condensers in some of the radio flivvers, as well as other recent improvements.

REGENERATION ON THE WANE

THE TREND of the past year or two in radio manufacturing has been toward stable circuits, rather than the super-sensitive but tricky circuits of several years ago, when one tube gave excellent volume of signal with head phones, and a three-tube receiver represented the standard loud speaker set-up. Thanks to the advent of economical vacuum tubes, requiring a fifth or less of the current formerly consumed by the tungsten filament tubes, radio manufacturers have found it possible and advisable to add tubes for handling the radio functions more in the way of the plodding and reliable day laborer rather than

THE RADIOLA 28

Is a desk model eight-tube super-heterodyne, working from a loop-antenna and using dry batteries. It is claimed that this receiver will give greater volume than that obtained with some storage battery operated receivers. The new RCA unicontrol tuning mechanism is incorporated, together with straight line frequency condensers, giving equal spacing of all stations on the tuning scale

the flashy and uncertain performance of the strong-arm man. Two additional tubes, performing as radio-frequency amplifiers, now serve to build up the radio energy in safe and sane manner, relieving the detector of that task formerly accomplished by means of so-called regeneration. A wonderful means of increasing sensitivity and volume, regeneration nevertheless did not belong in the home receiver. It is too unstable and difficult to handle, so far as the average layman is concerned. Hence it is best that this feature has been eliminated as the *sole* means of increasing sensitivity.

Going a step beyond regeneration, radio manufacturers have sought to control undesirable regeneration or oscillation in the radio set, by some inherent feature which might perform irrespective of the manipulations of the lay hand. Thus the squeals and groans so characteristic of early radio are no longer in evidence. In the less expensive receivers, oscillation is controlled by the simplest of means, namely, introducing certain losses which eliminate the possibility of oscillation. In the more elaborate receivers, this purpose is accomplished by various means which do not call for a sacrifice in efficiency.

One thing is certain: the elimination of the regenerative detector, at the expense of two more tubes, has made it possible for milady to operate the radio receiver. Furthermore, it has more or less standardized the service rendered by all receivers of a given make. Previously, regeneration was such a tricky thing that there was no telling just what might be accomplished with it. The skilled operator might tune-in San Francisco in his New York home. Next door, an average radio fan, with the same type of receiver, could do no better than a local station, and even then, the squeal just about drowned out the music. To-day, the non-regenerative receiver has virtually wiped out the advantage of the skilled operator. Once the dials are charted or logged for various stations, the ten-year-old child tunes just as well as Daddy who reads every radio magazine that comes along.

A similar observation is that the non-regenerative receiver has made it possible to put radio sets on a sort of miles-per-gallon basis somewhat approaching that of automobiles. With the operation of the set virtually reduced to a fixed standard, as compared with the widely separated extremes with the regenerative receiver, the performance of a given set is more or less accurately gauged in advance.

CUTTING DOWN CONTROLS

THE SUCCESS achieved with the multi-tube receiver has spurred radio manufacturers on toward less controls and simpler operation, which, in turn, means a more elaborate receiver. Whereas a year or two ago the radio public was content to set three dials to various numbers in order to tune-in desired stations, to-day that public wants to get away from such elaborate operation. Their ideal is thought by many to be the one-knob receiver, which is being closely approximated by some of the present offerings.

Electrically, there is no such thing as a

A DELUXE CONSOLE

A five-tube creation of the Electrical Research Laboratories (Erla), of Chicago. This is a fine example of exquisite craftsmanship, the cabinet being of quartered and matched figured walnut in the French Huguenot finish. Balloon Circloids, three of them, are used in the circuit, which employs two stages of tuned radio frequency amplification, detector, and two stages of audio

A KELLOGG RECEIVER

Is shown below. It is a highly sensitive, yet easy to control, seven-tube set, designed to furnish as closely as possible a satisfactory answer to the question, "What is the ideal form of radio for the home?" To the right is shown a beautiful example of loud speaker design, a product of the Seaman-Jones Fibre Products Company, of Chicago

QUALITY THE KEYNOTE

In this six-tube Air-Way tuned radio frequency receiver. The three audio stages employ the resistance-capacity method of coupling, and there are two stages of radio frequency amplification. This receiver is manufactured by the Air-Way Electric Appliance Corporation of Toledo, Ohio

THE BLAIR SIX

Employs three stages of resistance-coupled audio amplification. It gave very satisfactory results when tested in the RADIO BROADCAST Laboratory

THE "NO DIAL"

An innovation in receiver design, produced by the Ohio Stamping & Engineering Company, of Dayton, Ohio. The unusual method of control, by rotating the lid, does not appreciably detract from the efficiency of the set

THE RADIO FLIVVER

Alias, the Crosley 5-38 receiver. Despite their low cost, very excellent results are obtainable with this and other Crosley sets. A feature of the new Crosley model is the Crescendon, a volume control device exclusive with these sets

MILADY

Must be catered to as is evident after a glance at the two receivers to the left and right. The new Freshman Masterpiece has a real appeal to the women of the home. It is compact and has a built-in loud speaker, and sells for a few cents below the $100 mark. On the right we have an Italian Renaissance Console, truly an exquisite example of cabinet work. It is a product of the Valley Electric Company of St. Louis, Missouri. It is to their credit that manufacturers have made it a point not to sacrifice either quality or sensitivity for beauty of appearance

one-control set. The various tuned circuits of a radio receiver must be controlled individually by their respective tuners. However, by ingenious mechanical arrangements, it becomes possible to operate simultaneously the various tuners, generally variable condensers, with a single knob, thus simplifying the operation.

It is no easy matter to tune several radio circuits simultaneously. Mechanically, it seems simple enough. The variable condensers can be arranged in tandem—their shafts connected together in a straight line—for rotation in unison or, they can be joined together by gears, chains, or levers But the real complication comes in the electrical or radio performance. Unfortunately, variable condensers will not run uniform throughout their capacity range and, while three condensers may match up very nicely for one wavelength or frequency setting, they may be 'way off at another.

As a consequence, the earlier one-knob receivers were of the crudest form from the radio standpoint. The various circuits were tuned to utmost efficiency at one frequency setting, at most. At all other settings the circuits were tuned so far apart as to impair the sensitivity and selectivity of the receiver. Manufacturers sought to correct this shortcoming by introducing supplementary condensers for the final sharp tuning of the individual circuits, but by so doing they immediately defeated the very purpose of the one-knob receiver.

As one radio engineer has so pertinently put it, any one can build a good single-knob receiver—provided there are sufficient supplementary controls! And any one can build a one-knob receiver, provided the results are not compared with a multi-knob receiver utilizing the same number of tubes. So the one-knob is either a misnomer, because it involves supplementary controls, or it is a wonderful achievement in radio engineering and precise manufacturing methods.

To-day, there actually are examples of the wonderful radio engineering achievements on the market. The design of such receivers has been worked out with infinite care, in the case of the best one-knob receivers, and as a consequence, these offerings are costly. In fact, certain one-knob receivers have been made possible only by an entirely different method of building the variable condensers, involving a precision heretofore not even thought possible in factory production.

The one-knob receiver is the ultimate in radio reception. There can be no doubt of it. Nothing provides a greater thrill, even to the hard-boiled radio man, than to turn the single knob or drum slowly from the low to the high numbers, while the various broadcasting stations fade in and out in a steady procession. It is positively uncanny. One of the present single-control receivers has its dial readings arranged to represent frequency separations of ten kilocycles, the standard separation of radio broadcast channels. Stations can be instantly tuned-in, by turning the single drum control to the frequency setting.

But single control means an elaborate receiver, costly production, and high cost. Hence the multi-control receiver must remain with us for quite a while to come. It saves money for the radio buyer and manufacturer alike.

THE COST OF TONE QUALITY

THE greatest advance scored in radio receivers during the past few months has been in tone quality. Just so long as radio broadcasters were transmitting crude approximations of music, and just so long as loud speakers were still following in the footsteps of the horn-type phonograph, tone quality did not receive much attention. In fact, the public was more than generous with radio acoustics, accepting the crudest performance willingly enough.

Then, the radio broadcasters began to move ahead in the matter of tone quality. Better equipment was installed, for the purpose of transmitting a wider band of musical frequencies and furnishing the subtle overtones and harmonics so essential to realistic rendition of music and speech. Meanwhile, loud speakers were being studied in laboratories, from the standpoint of sound. Soon the cone speaker made its appearance, providing a means of reproducing virtually all musical frequencies from the lowest to the highest. The problem then became one of furnishing the loud speaker with a true copy of the musical frequencies impressed on the broadcast wave. And the audio frequency end of the radio receiver heretofore, left alone in the more important quest for new circuits and other things, now came in for a cross-examination.

Under the concentrated efforts of the radio fraternity, remarkable things have been done in audio frequency amplification in the space of months. Transformers have now appeared which are capable of amplifying a wide range of musical frequencies without distortion, or, to put it another way, with equal amplification for all musical frequencies from the lowest to the highest encountered in the average broadcast program. With a full realization of the limitations of even the best audio-frequency transformers, other methods of amplification have been investigated and developed, notably resistance- and impedance-coupled amplification.

THE PFANSTIEHL SINGLE—DIAL SIX

A novel feature of which is the built-in Tungar charging rectifier of the 110-volt, 1½-ampere type. A circular window on the panel permits the reading of the charging indicator with the least possible inconvenience, no separate hydrometer being necessary to test the Philco glass contained storage batteries

Receiver manufacturers have not been slow to appreciate the importance of tone quality. In the better grade of offerings, tone quality is taken care of by present-day transformers—veritable giants compared with the little transformers of a year ago. Some offerings even include resistance-coupled or impedance-coupled amplification. While the lower priced sets will not, as a rule, perform satisfactorily with a cone speaker, because of the limitations of their transformers, the medium priced and the higher priced receivers should operate a cone speaker very nicely. Unless a receiver is capable of rendering good quality amplification, it will work far better with a horn type speaker.

Another trend to-day among the better sets is toward the self-contained offering. Originally, there was the tuner, the detector unit, the amplifier unit, the loud speaker, the batteries, and the wave-intercepting system. Some time ago radio practice had come down to the tuner, detector and amplifier in one unit, with the accessories scattered about. Today, there is a definite move toward combining the loud speaker, batteries and even the wave-intercepting system with the receiver proper, all in one handsome piece of furniture. Whether or not this is good practice is for the buyer to decide. There are pros and cons in abundance. The matter seems to simmer down to one of personal preference.

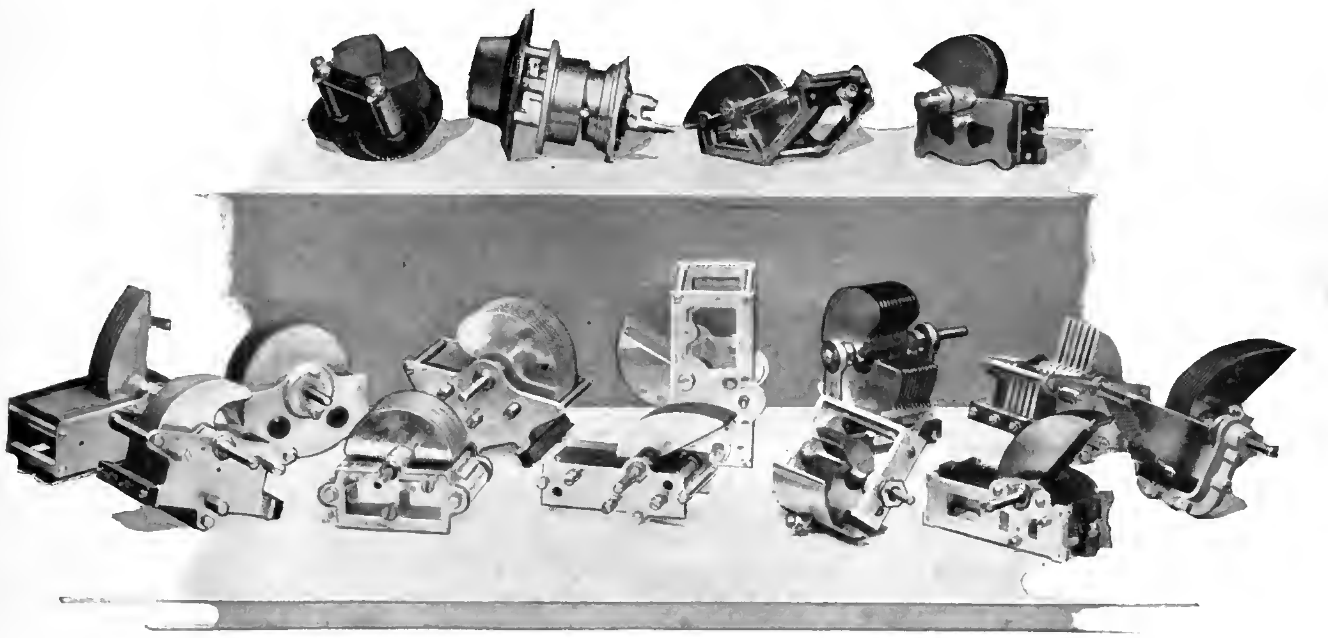
Let us briefly review both sides: The self-contained receiver has the advantage of neatness, compactness, and the presumable balancing of the accessories with the receiver, so as to provide the best possible ensemble. The receiver with separate accessories has the advantage of perhaps lower first cost, since the buyer can secure the equipment as he wishes; while various combinations can be tried to meet individual taste and pocketbook, and anything new can be introduced in the receiver layout.

Many of the present-day offerings now include a built-in loud speaker, a battery with trickle charger, a B power supply, and a handsome cabinet. Loop receivers, of course, include the self-contained wave interceptor.

The development of the cabinet end of the radio set has been an interesting one to follow. Originally, the cabinet was little more than a protective case. Then, with the debut of the home radio from the attic or spare room into the living room, the cabinet took on better wood and better finish, but still remained plain enough. More recently, the console type of cabinet has appeared, so that the radio receiver can stand on its own feet in some desirable part of the living room or other convenient part of the home. And now, there seems no limit to the radio cabinet, ranging from the simplest case for the inexpensive radio receiver which is 95 per cent. radio and 5 per cent. cabinet, to the most elaborate offering which may be 95 per cent. cabinet and 5 per cent. radio. Furniture radio has been a wise move. It has done much to popularize radio, especially with the fair sex who judge so much by appearance. There is only one danger, and that is the sacrificing of radio to the furniture end. Here and there, among current offerings, one finds instances of furniture with a radio feature, rather than radio with a furniture feature. Too much furniture is as bad as too little, if it means the sacrifice of the radio end. This is especially true in some popular priced offerings which include an elaborate piece of furniture, with a corresponding retrenchment on the radio end. After all, it is radio that is being bought—a seat in the broadcast auditorium—and not a piece of furniture as furniture alone.

Decidedly, the manufactured radio set has come into its own. The radio fan can now purchase a receiver which will provide all the essentials of good radio reception, including sensitivity, selectivity, tone and economy. What is more, he is buying a finished product and not an experiment. And his radio dollars will bring him greater value to-day than ever before.

Will the New Type of Condenser Improve My Set?



What the 10-kilocycle Separation of Stations Means and How to Decide the Best Condenser to Use—How Condenser Plates are Designed Advantages and Disadvantages of the Three Types

By KIRK B. MORCROSS

WHY are broadcasting stations crowded together at low settings of the dials of receiving sets? This question arises in consideration of the fact that frequency assignments to broadcasting stations give a uniform spacing of ten kilocycles between them. A little of this irregular spacing on the dials is due to deviations of some broadcasting stations from their assigned frequencies which are sufficient to cause a noticeable change in dial settings. Such irregularities are, however, slight. There would be essentially the same crowding even though each broadcasting station transmitted at *exactly* its assigned frequency.

One might say that this crowding on the dials occurs because the shorter wave stations have less wavelength separations. This is, indeed, true—at least for the majority of receiving sets. However if we try to solve the difficulty by looking at it from this point of view and apply what is apparently the natural remedy of uniform wavelength separation of broadcasting stations, we are going to get into trouble. Having thus allocated these stations, we would find it a simple matter to separate them equal distances on the receiver dials by using straight line wavelength condensers. However, in adopting this allocation a certain *minimum* separation in kilocycles would be required in order to prevent undue interference and the production of an objectionable beat note between carrier waves. This separation is found to be about ten kilocycles. If then, we assign wavelengths to the longest and next longest wave broadcasting stations so that these stations have a ten-kilocycle separation (corresponding to a wavelength separation of 9.7 meters)and then give a uniform wavelength spacing of 9.7 meters to all broadcasting stations down to the shortest wave station, the kilocycle separation increases rapidly. At the lower end of the broadcast band it becomes approximately 70 kilocycles! In these days when every available radio channel is sorely needed, no argument is necessary to show the absurdity of such a method of allocation.

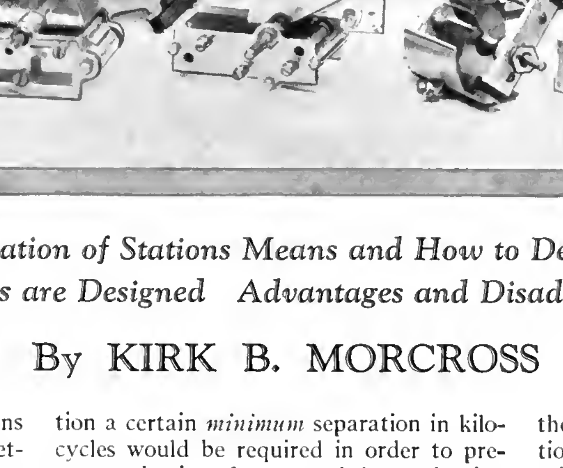


FIG. I

The three curves indicating the tuning characteristics of a straight line capacity condenser show several things of interest. Curve A demonstrates that for a progressive similar increase in the condenser dial reading, the capacity of the condenser changes each time by the same amount. Curves B and C prove that if an equal separation in kilocycles or wavelength is desired, this is not the type of condenser to employ in your receiver

On the other hand, the allocation of stations by a uniform kilocycle separation gives the maximum number of radio channels. Hence, in order to reduce crowding on the receiver dials we must turn our attention to the receiving set, or more specifically, to the shape of the plates of the variable condensers.

There is another alternative to changing the shape of condenser plates. One may take an ordinary condenser and apply to it a properly designed mechanism so that for a given angular rotation of the dial, the same *frequency* variation takes place regardless of whether the condenser is being adjusted at large or small capacities. Devices of this kind are now on the market and some broadcast listeners may prefer them to the purchasing of

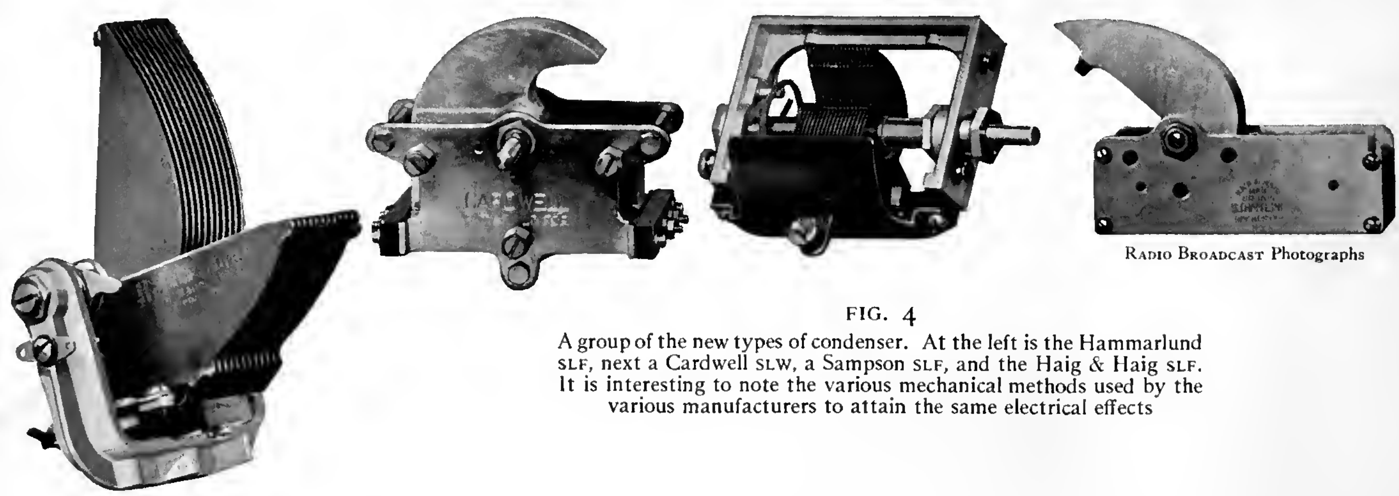


FIG. 4

A group of the new types of condenser. At the left is the Hammarlund SLF, next a Cardwell SLW, a Sampson SLF, and the Haig & Haig SLF. It is interesting to note the various mechanical methods used by the various manufacturers to attain the same electrical effects

new condensers. The photograph Fig. 6, shows a well-known device of this sort.

The commonly used condensers are the so-called "straight line capacity," "straight line wavelength" and "straight line frequency" types (Hereafter called "SLC," "SLW" and "SLF"). The expressions SLF, SLW, and SLC, referring to condensers of straight line frequency, wavelength, or capacity characteristics are used in the rest of this article for convenience. The writer is not attempting to consider mechanical construction or "low loss" characteristics in this discussion; such properties are satisfactorily met in the majority of condensers on the market. The question that many broadcast listeners are asking is this: "What improvement in results will I get from my receiving set by substituting condensers giving more uniform spacing of stations?" It is in answer to this question that this article is written.

Before taking up a discussion of condenser construction it will be very useful to consider the function of condensers in receiving circuits. We will take an imaginary case of two receiving circuits identical in all respects except that one uses SLF or SLW condensers while the other is provided with SLC condensers. Suppose both circuits are tuned to the same broadcasting station and let us also assume that other stations are broadcasting at or near this same frequency. Assuming that the condensers and associated coils in the two circuits have the same losses (which is a fair enough assumption) then each circuit will experience *exactly* the same amount of interference from stations of a frequency numerically quite similar.

This simple illustration serves to show that no particular type of condenser is superior at eliminating interference simply because it has plates of special shape. Nevertheless such condensers often assist indirectly in reducing interference because they give greater spacing of stations on the dials, permitting more accurate tuning to a particular station. It will be seen that this advantage becomes less in some of the larger cities where the receiving set is located near several broadcasting stations.

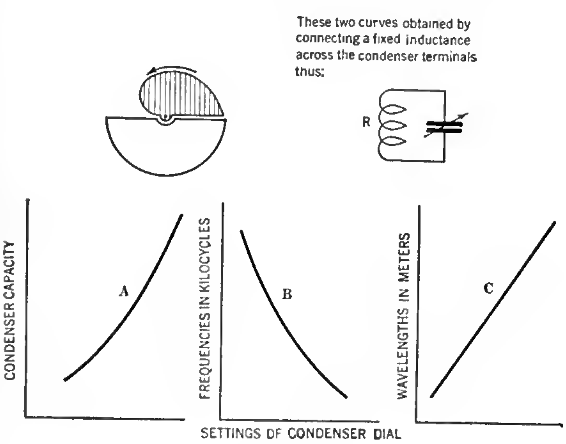


FIG. 2

Now we come to the straight line wavelength condenser whose tuning characteristics are depicted in the curves A, B and C, above. In C it is shown that for a definite successive increase in condenser dial reading there results a very definite change in wavelength, each change differing from the last setting by the same amount, in wavelength

Practically all of the older types of receiving sets have SLC condensers (semi-circular rotating plates). Under what conditions should these be replaced by SLW condensers? The answer to this question will be made easier by a little consideration of the characteristics of the SLC and SLW condensers. The former type gives *linear* capacity variation with dial settings—that is, if the dial is rotated from say 80 to 90, the capacity is increased the same amount as when the dial setting is changed from 20 to 30. This is shown by a curve plotted with units of capacity along the vertical axis and dial settings along the horizontal axis, Fig. 1A. The curve is a straight line except for deviations near the ends—particularly the lower end.

Now suppose we adapt this condenser to the usual condition in a receiving circuit by connecting it to a fixed inductance as shown at R, Fig. 1. What happens? When the capacity of the condenser is varied, the circuit is tuned to the frequencies of various broadcasting stations. If we now plot a curve (Fig. 1B) using dial settings on the horizontal axis as before and frequencies in kilocycles along the vertical axis and another curve using wavelengths along the vertical axis, we find that neither curve is a straight line. They become steeper as the dial settings *decrease*. Hence a given rotation of the dial near the lower end of its scale produces a *much greater* change in frequency or wavelength. Therefore in tuning to broadcasting stations of high frequencies (short wavelengths) we find them crowded together on the condenser dials. In practice, this condition appears still worse because more stations broadcast at the higher frequencies.

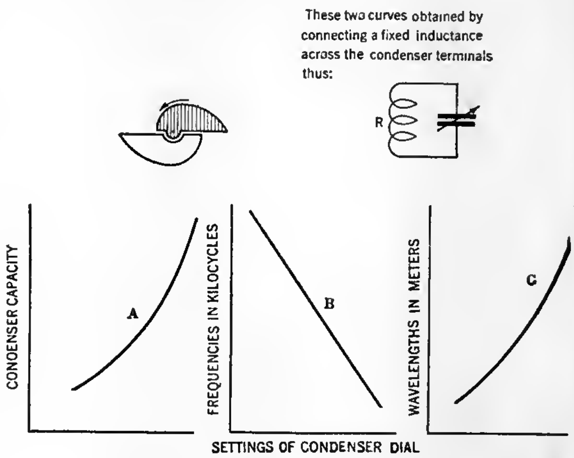


FIG. 3

Curves illustrating the peculiarities and advantages of the straight line frequency condenser. Since broadcasting stations are assigned to frequencies differing by 10 kc., then a condenser that would produce a definite rate of frequency response would be desirable. This the SLF condenser does

To reduce this crowding, one may substitute SLW condensers for the SLC types.

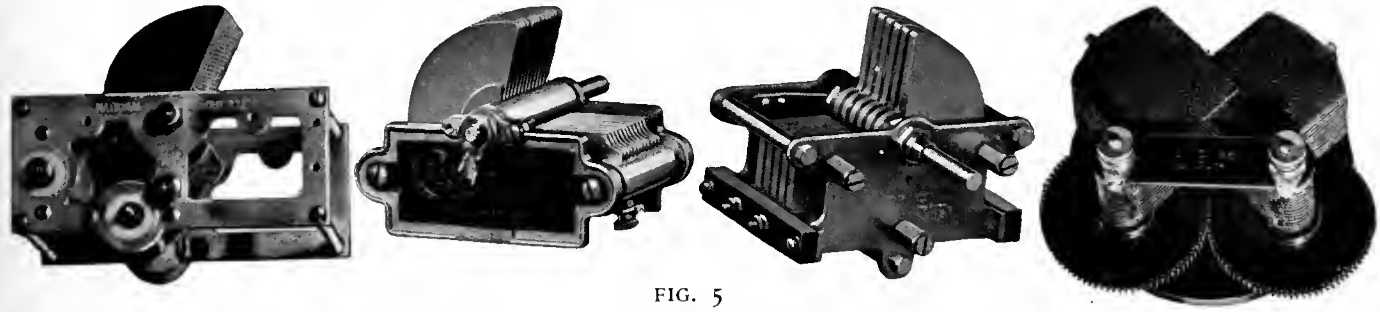


FIG. 5

A combination of SLF, SLC and SLW condensers. From left to right the National Equicycle, The Craftsman, the Cardwell taper-plate, and the Remler

RADIO BROADCAST Photographs

FIG. 6

The Rathbun straight line frequency converter dial, and a view of its inner "works." For those who prefer to keep their straight line capacity condenser but desire the effect of straight line frequency tuning, this dial may be used

RADIO BROADCAST Photograph

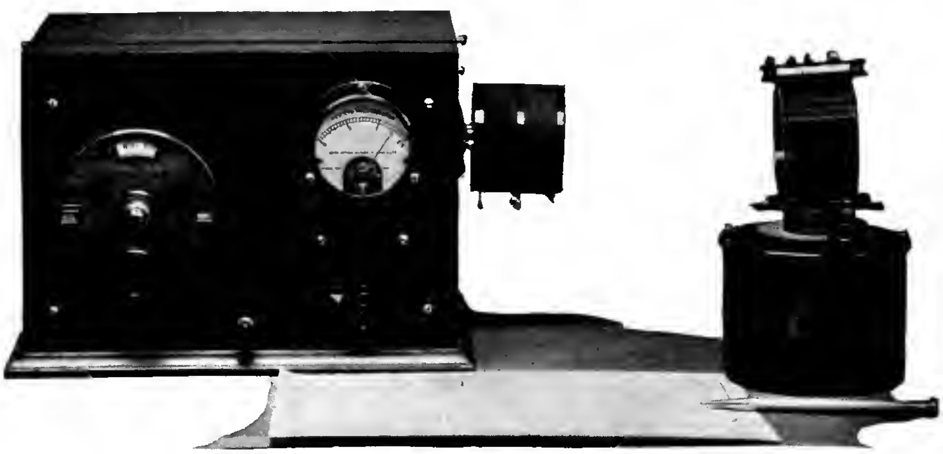
Curves for this condenser are shown in Fig. 2 and should be compared with Fig. 1. In discussing the capacity curve for the SLC condenser mention was made of irregularities near its ends. As one might expect, similar effects are present in curves obtained from condensers having plates of various shapes. These effects occur only at the extreme maximum and minimum dial settings and need not be discussed further.

The curve in Fig. 2C is a straight-line; hence a given change in dial setting *anywhere* will produce the same change in wavelength. Therefore if broadcast wavelengths were equally spaced in meters, the SLW condenser would give ideal separation. Actually, since the shorter waves are more closely spaced, the short-wave stations will likewise be more closely spaced on the dials, although better spacing is obtained than with the SLC condenser. If you are in doubt about changing to SLW condensers, ask yourself the following questions:

(1) Is it difficult, with my present type of condenser, to set the dials accurately for the required wavelengths? (2) Is it difficult to predetermine the dial settings for a new wavelength? If the answers to these questions are affirmative then it should be worth while to substitute in your receiver SLW condensers for the SLC types.

STRAIGHT LINE FREQUENCY CONDENSERS?

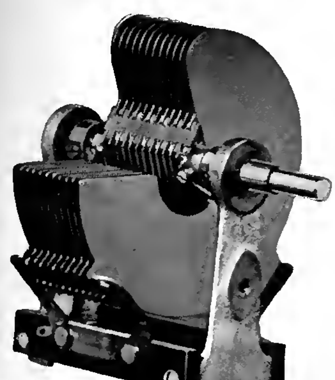
OUR next question is, "When should one substitute the SLF condenser for the more conventional types?" In answering this question let us refer to Fig. 3 which shows curves for the SLF condenser. These should be compared with those in Figs. 1 and 2. Curve 3B shows the ideal characteristic of the SLF condenser—that of uniform spacing of broadcasting stations. This condenser, however, has the disadvantage of requiring much more space for the same maximum capacity than the



RADIO BROADCAST Photograph

FIG. 7

To plot curves showing the characteristics of various types of tuning condensers, it is necessary to have a calibrated source of radio oscillations which may be interpreted in terms of frequencies, wave lengths or capacities. Such an instrument is known as a driver or oscillator and one was described by Mr. Keith Henney for the Home Constructor in the September, 1925, RADIO BROADCAST. The coil and condenser located at the right of the photograph represent the circuit comprising a fixed inductance and a variable capacity and by tuning to settings of the oscillator, a series of readings are obtained, which, when plotted indicate the characteristic curve of the condenser and coil being tested



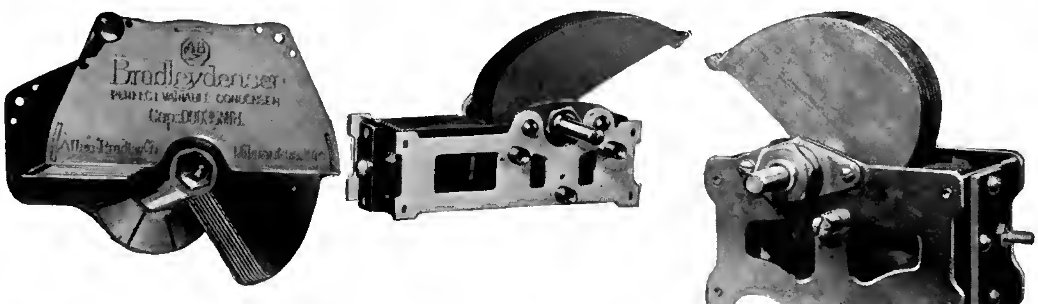


FIG. 8

Other condenser models. The Kellogg at the left, the Bradleydenser, the Preferred, and the Erla. In turn they are SLW, SLC, SLF and SLW

RADIO BROADCAST Photographs

What Condenser Shall I Use?

Here are some questions to ask yourself as you consider which of the three available types to use.

If you debate using the straight line wavelength type:

1—Is it difficult, with my present type of condenser, to set the dials accurately for the required wavelengths?

2—Is it difficult to predetermine the dial settings for a new wavelength?

If the answer to these questions is yes, then the straight line wavelength type will meet your needs.

If you are considering the use of the straight line frequency condenser, ask yourself these questions:

1—Is there sufficient space available for mounting them?

2—Have the condensers in question, sufficient maximum capacity to suit the requirements of the receiving circuit?

3—Have I difficulty in adjusting my present condensers to the higher frequency (shorter wavelength) stations?

4—Is it difficult to locate new stations?

SLC condenser and considerably more space than the SLW condenser. However, some new types now on the market are designed to fit in the same space as that occupied by the conventional SLC condenser found in so many radio sets. Another disadvantage of the SLF condenser is the difficulty of making it sufficiently small in zero capacity consistent with securing the desired maximum capacity. On the whole, these drawbacks are by no means serious and are largely overcome by proper design.

In considering the adoption of SLF condensers, make sure of these points: (1) Sufficient space for mounting. (2) Sufficient maximum capacity to suit the requirements of the receiving circuit. In addition, ask yourself these questions: (1) Do I have difficulty in adjusting the present type of condensers to the higher frequency stations? (2) Is it difficult to locate new stations?

These questions are similar to those for judging the SLW condenser; however they should be considered more from the view of the broadcast listener who is most interested in tuning-in a great many broadcasting stations, or separating a multitude of local ones.

Thus far nothing has been said of the theory of design of condenser plates. This subject is not uninteresting—even for the non-technical radio fan—and a little knowledge of this kind is a considerable help in determining the most suitable condenser for the receiving circuit. Owing to lack of space this discussion must be brief.

The shape of the plates of the SLF condenser can be determined from the formula:

$$R=\sqrt{\frac{K}{D^3}+r^2}$$

where R = distance from center of rotation of plate to the edge,
r = radius of cut out portion of fixed plates,
and K = a constant determined in designing the condenser.

Fig. 4 shows the shape of plate obtained principally by computation from this formula. The formula has some interesting peculiarities. It shows that as R increases the dial setting *decreases*. Hence if in attempting to determine K, we assume the maximum value for R, D is zero and the equation is indeterminate. However we *can* determine K by assuming R at some other dial setting. For instance,

R = 4 centimeters when
D = 20. Then if
r = 0.8 centimeter,
K = 122,900.

We can now place these values of R and K in the original formula and solve for various values of R corresponding to assumed values of D between 0 and 100. As D approaches zero R becomes enormous, and when D is zero R is infinite! Consequently the curve in Fig. 10 never reaches the zero line x-y. To overcome this difficulty, a point z is selected and a straight line is drawn through it and the point O. This produces an area shown in black which when added to the rest of the plate will complete its shape to give 180 degrees rotation. In actual practice, this long thin plate may be made somewhat "fatter" without greatly affecting its straight line characteristics.

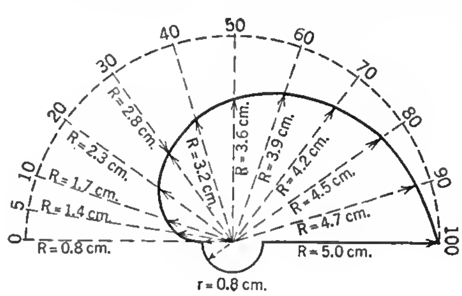


FIG. 9

The template for a SLW condenser rotor plate drawn to scale. The mathematics governing the computation of this odd-shaped plate are fully explained in the text

The shape of the rotating plates of the SLW condenser is determined from the formula:

$$R = \sqrt{KD + r^2}$$

Suppose we wish to design a rotating plate having

R (maximum) = 5 centimeters
and r = 0.8 centimeter.

This means that

D = 100 (or 180 if the dial is marked in degrees).

We then substitute these values in the formula and solve for K thus:

$5 = \sqrt{(K \times 100) + 0.64}$, from which K = 0.24, which is now inserted in the original formula together with the value of r^2 giving:

$$R = \sqrt{0.24D + 0.64}.$$

Values of D, ranging from zero to maximum, are now assumed, the formula is solved for each corresponding value of R and a curve is plotted which gives the required shape of plate. There is not sufficient space to give these computations, but one can understand the method from Fig. 9 which the writer has drawn to scale.

Other shapes of rotating plates than those described in this article are used to secure straight line wavelength and frequency effects. Sometimes the *stationary* plates are given a special shape; again, some condensers are made with two sets of moving plates. In actual practice, a truly straight line wavelength or frequency curve is seldom obtained, but the curvature is generally so slight that it is of no practical consequence.

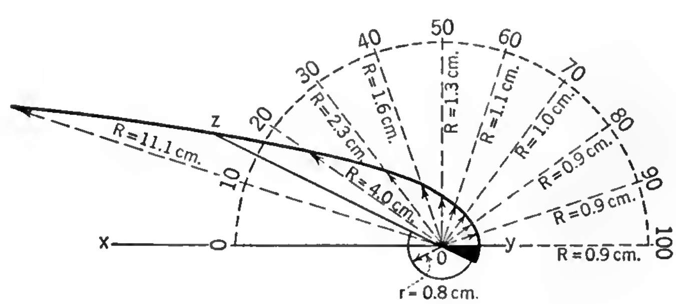


FIG. 10

The template for the SLW condenser rotor plate looks like this. Some condensers have variations of this general outline by providing changes in the stator plate to maintain the proper ratio of increase between rotor and stator plates

The Listeners' Point of View

Conducted by —— *John Wallace*

The Announcer as an English Teacher

AMONG the functions attributed to radio by its more enraptured admirers is that of "cure-all."

Radio, the prize production of the twentieth century, is going to make the world safe for democracy, bring the heathen light, keep the boy off the streets, encourage home cooking, give wits to the witless, prevent war, and bring about an early Utopia.

Particularly clamorous are its devotees in proclaiming its cultural influence. It is the harbinger of the Super Man, the token of a new and greater civilization. In short, it is going to do everything that the printing press was expected to do—and didn't. Alas for the printing press: the widest circulating newspapers pay a bigger bill to the photo-engraver than to the typesetter. The yokel who isn't quite sure what m-u-r-d-e-r spells, at least knows what the big black X marks in the picture of South River Street.

Radio, as regards its educational probabilities, occupies a position slightly southeast of the tabloid newspaper. But in matter of making ladies and gentlemen of all of us, radio could be a factor in improving the native "polite" speech. Of course it isn't doing this. The large majority of persons behind microphones possess a vast ignorance of the English language as she is spoke.

Newspapers, even the worst of them, pride themselves on one unassailable standard i. e. accuracy in spelling—particularly of proper names. Any one who has witnessed the destructive antics of a Mr. Yjer J. Pheudellski at the city editor's desk following his mention in print as Mr. Yjer J. Pheudlletsky, will not wonder at this precaution. Pronunciation, however, is the least of a newspaper man's worries. The city editor probably called the above gentleman Mr. Fiddlestick, if, indeed, not something worse. Radio announcers, relieved of the worry of correct spelling, should, by way of evening the scales, be sticklers for exactness in pronunciation.

Now, to get to our "cure-all" point, reading right spelling in newspapers is not likely to make spelling champions of all of us, but hearing a word pronounced a certain way night after night is pretty certain to influence our pronunciation of that word. Hence radio's opportunity to play the rôle of reformer.

A reader writes in to complain of one announcer saying in swift succession: *jeopar'-die*, *vised* for *vi-sé*, and *the-a'-ter*. We recall a *Meditation* from "*Thay-is*," a Sampson and Delilah selection by "*Saynt Sayns*," and . . . well why go on? Lest we sound too harsh, we will readily grant that we'd hate to try to pass an oral test on any five furrin' names. We wouldn't gamble on getting two right. (We haven't yet learned how to pronounce Chartreuse in a manner that will elicit response from a Parisian bar tender.) But all the same, if an individual sets himself up as announcer, and hence speaker to the millions, he has, we think, let himself in for a conscientious job of brushing up on his aspirants and liquid l's. And his vocabulary, as soon as he sets up in business as announcer, is a matter of public concern. His command of words should at least equal that of his average listener.

Once we were told we had been "listening to an ultra-cultural program of semi-classical songs played on the wonderful twin organ at superstation XXX." "Ultra" and "super" have been poohed at by better pooh-poohers than we. "Wonderful" is the delight of all illiterate enthusiasts. It is stretched to cover all manner of virtues, whether or not they inspire wonder.

We offer a fine bag of peanuts to the person who can prove there is any such word as "semi-classical." It belongs, we maintain, on the same shelf as "very unique" and "half dead." But that is a moot point. The radio expression that drives us into paroxysms of rage is that most detestable word: Kiddies. Why not, oh ye Uncle Charlies and Aunty Janes, call them Children? That's what they are. The other appelation was coined by sweetly smirking old maids of both sexes. No one ever heard children refer to one another as "kiddies" so why attempt to foist the saccharine moniker on them. "Kids" is well and good; or, if that be too undignified, simply: Children.

The WLS Prize Play

"THE Night Herd," the prize winning play in the contest conducted jointly by WLS and the Drama League of America, made its première last February before what must have been about the biggest first night audience in the history of play producing. And the occasion was made an auspicious one.

Mr. George Arliss, who was in Chicago playing in "Old English," made some well chosen introductory remarks; very gracefully pulled the inevitable pun about the play being "night heard"; and presented the Hoover Trophy Cup to the author, Levi Ballou.

And by way of adding further glamour to the event, two legitimate stage stars were pressed into service in the principal rôles. With all these fine trappings it was a bit unfortunate that the play itself didn't quite live up to its send-off.

The action of the play is laid in the Western cattle country. There are but three characters: "Tex", a cowboy who is playing night nurse to the herd (Holbrook Blinn, star of "The Dove"); "Lolita," the dissatisfied wife of another cowperson (played by Nance O'Neill) and "Jim" her husband (Harry Dean Saddler, WLS dramatic director.)

The station announcer simply read the list of players and stated that the scene was a ranch at two in the morning and that the principal character, Tex, was patrolling the herd on his horse. So much for the start—excellent in its brevity.

Then the play. First is heard the voice of Tex crooning a soft melody to his mount "Buck." The distant bay of the coyote, the occasional rustling of the moving herd, and the rhythmic sound of the horse's hoofs galloping over the plain constitute the only scenery.

By the clever device of having Tex talk to his horse, the author makes known the situation. Tex is in love with Lolita, whom he had known "down South" and who is now married to his fellow worker Jim. Then a crescendo of hoof

PROF. PAUL STOYE
Who is heard on the Monday program of WHO at 7:30 to 8 P. M.

beats announces the appearance of Jim. The two pledge their friendship. After Jim has left to attend to his own duties, up gallops Lolita, who ought to have been in bed long ago. This fickle corner of the triangle has discovered that it's really Tex she loves after all, and she launches forth on an impassioned plea that he take her back with him to the Rio Grande country.

This, of course, puts Tex in an awful jam. for he is thoroughly in love with the lady. But there is also his friendship for Jim to be considered. So being a denizen of the "great open spaces" and hence a Man, he breaks away from Lolita's amorous clutch, bids her be off, and rides slowly away, singing softly to himself. Finis.

The play was not a "wow," but it had so much to recommend it that the contest can be regarded as a success, and the author's efforts praiseworthy.

In the first place, the play was essentially radio drama, i. e. it was better adapted to radio than the stage, for the locale was shifting constantly as the horses galloped on. Secondly the "atmosphere" effects, such as the howl of the wolves, were convincing and suggestive. Thirdly there was never any doubt as to who was speaking.

But the story itself was trite and unconvincing. While the leads professed to be in the throes of dramatic mental anguish, their worries didn't quite secure our sympathy. And we were sorry that the play's unique feature—that the scene of the action was constantly shifting—wasn't made more of. As a matter of fact all the action could have taken place on one spot. Not a great play, but at any rate, a step in the right direction.

Poets as Broadcasters

JAMES STEPHENS, the Irish poet, gave a reading of his verse over WGN some time ago and we have since wondered why this radio possibility has not been further exploited. Poetry, if it be genuinely such, gains by being read aloud. And the opportunities for hearing poetry recitals are few and far between. Most contemporary poets undertake an at least occasional speaking trip to stimulate the sale of their volumes, but they only visit the larger cities, and never tarry for more than one public recital.

It has been paradoxically stated that no poet knows how to read his own work, but whether this be true or not, it is nevertheless interesting to hear his own interpretation of it. Besides, warrantable or not, there is always an interest added to a man's work if the man himself be known.

In the case of James Stephens (the only poet of any consequence we have yet heard by radio) his delivery of his own work was delightful, and we question if any reader could do as well by it. Mr. Stephen's persistent brogue is no small factor in his charm.

The days when ladies, dressed as Greek maidens, recited interminable poems to the accompaniment of a proscribed, and gymnastic, succession of gestures is happily over. No one, outside of high schools, reads verse any more, with any gesture other than that which is unconscious and uncontrolled. So the radio audience has nothing to lose in not observing the poet. (Though in the instance of Mr. Stephens, one who has never witnessed his intriguing appearance has missed a large share of his interesting personality).

Doubtless other poets have broadcast their works, but as we have happened on only this one instance we infer that poetry recitals are not, as yet, a frequent program feature.

The reason for this may be in the almost universal precaution exercised by program directors never to high-hat their audiences with anything too high-brow; or in the traditional timidity and modesty of the poets themselves; or in the failure of the publishing houses to realize that in radio lies their opportunity to clear their shelves of piles of dust gathering on "slim volumes."

Bring on the bards!

OPAL HEMLER

Soprano who has been heard from WTAM, at Cleveland. Her pleasing voice was heard by a listener in England who tuned-in WTAM last November. Mrs. Hemler was recently added to the staff of WTAM as assistant program director

©Drake Studio

JAMES STEPHENS

Irish poet and novelist who read some of his verse over WGN some time ago. Mr. Stephens is the author of *The Crock of Gold*

Shakespeare by Radio

THE considerable time that elapses between the writing of this material and its appearance in print occasionally results in our pleas being answered quite a while before they are even made known. Such a state of affairs is however, effective in preventing us from complacently imagining that our words brought about the desired reform.

As an instance of this, we urged in the March issue, that more attention be paid to the possibilities offered in Shakespearian production. In February, WEAF did that very thing. And we were pleased to note that the efforts were even more successful than we had hoped they would be. And WEAF started off its series of tabloid presentations of Shakespeares dramas with "The Merchant of Venice." From start to finish the performance was eminently successful. The actors were intelligent and well versed in the tradition of Shakespearian production. Their interpretation of the lines was in accordance with the soundest judgment. Shakespearian lines, by the way, are no small task to read correctly; the slightest misplacement of stress may alter the whole meaning.

But perhaps the most praise should go to whomever it was, who "cut" the play to adapt it to a one hour presentation, for it was excellently done. All the sub-plots, with which "The Merchant of Venice" abounds, were eliminated, and only the thread of the principal narrative sustained. This made possible the elimination of all but eight characters, leaving, principally Antonio, Bassanio, Shylock, and Portia.

This "cutting" was not continued to the point of mutilating the text. Whenever a scene was given it was given in its entirety and (we followed the play with the book) only very occasionally was a word dropped out. The abridger managed to preserve most of the famous-soliloquies, for instance the "Quality of mercy" passage and Shylock's "Hath a dog money?" speech. Of course it will be protested, and with some reason, that we of the twentieth century should not seek to re-hash Shakespeare's immortal words, nor attempt to condense into one hour the material he wrote for three hours.

But such a protest is largely footless. Shakespeare constructed his plays with such nicety that it is possible to remove their joints and yet find their integral parts structurally intact. Besides, even if this be called a makeshift, and a lazy man's way of becoming acquainted with Shakespeare, it is better than no knowledge of him at all. Shakespeare's plays are more suited to reading than those of any other playwright in the entire history of drama. But he wrote them primarily for oral production, and in the very music of the spoken words is much that is lost in a mere silent reading.

WEAF presented as its second Shakespeare program, "Romeo and Juliet," which was followed later by "Hamlet" and others.

Communication

THE following letter, which we quote in part, was addressed to a commercial broadcasting station—the nameof which is of no consequence—and a copy forwarded to us.

Broadcasting of any kind is advertising, be it religion, politics, or merchandise. Who benefits

MME. ERNESTINE SCHUMANN-HEINK

Her concert proved to be one of the best and most popular in the Atwater Kent series which have been delighting radio audiences on Sunday nights for many weeks from the broadcasting? The much-discussed Broadcast Listener receives entertainment—infrequently; you receive notoriety, which brings you hard, iron dollars—or you wouldn't do it. Who pays for the broadcasting? The Broadcast Listener!! Every penny of it! I am fed up with this ceaseless chatter about the "sponging" of the B. C. L.! Why are there nearly six hundred broadcasting stations on the air, and a waiting list of over four hundred? Are these persons so saturated with altruism that they rush into the spending of real money so they may uplift humanity with their various noises? Are these singularly philanthropic persons casting their golden bread upon the waters *hoping* to get some of it back? Hardly—to both questions; they haven't the slightest interest in humanity, and the results, financially, of this apparent disinterested largesse are figured out to the fraction of a cent.

I am tired hearing such persons as DeWolf Hopper sneer at the people who happen to be listening to a broadcast of which he may be a component; these same people have kept him in luxury for a lifetime. I resent the attitude of condescending tolerance with which the broadcasters view the rest of us. And if a lot of this silly cant doesn't cease there will be no listeners—and one wonders if broadcasting will continue in spite of that fact, if set manufacturers will keep on producing receivers even though they have no sales, if the radio combine will go on pouring out money on high powered stations to which no one listens. Again, hardly. When nine million persons like me are forced to feel that we are poaching and doing a discreditable thing every time we tune-in, right there we stop!

And the item of blatant advertising: no one objects to WEAF's announcer telling us that we are indebted to the Goodrich Company for the excellent entertainment afforded by the Silvertown Cord Orchestra; or the Eveready Hour; or the Goldust Twins; or Roxie; or Atwater Kent. All advertising; all household words; but none of them insistent or in the least objectionable. How long do you think an audience would listen to the A & P Gypsies if every number were followed by a dissertation on the quality and price of their beans and pickles? A single, dignified announcement is quite sufficient.

You may have a meritorious article you wish to get before the public, but you overreach yourself when you go about it in the manner I objected to the other night. And if you spend six thousand dollars a week for advertising, please remember that it doesn't cost *you* a red farthing. *I* pay the bills when I buy Salicon, and if I didn't you would inevitably go out of business.

WILFRED TAYLOR.
Thompson, Connecticut.

Broadcast Miscellany

ADD to the opera companies at your beck and call, if such be to your liking, the Rochester American Opera Company which broadcasts Wednesday nights through WHAM and WGY. This company is an outgrowth of the Opera Department of the Eastman School of Music, University of Rochester, and is under the direction of Vladimir Rosing. The series has been tabloid in form, and rather well cut. Orchestral accompaniment is by musicians from the Rochester Philharmonic Orchestra.

BY WAY of showing off its not inconsiderable wire connections, WGY pulled an interesting stunt some time ago; for periods of fifteen minutes it sent out music from New York, Cleveland, Poughkeepsie, Albany, Schenectady, Syracuse, Rochester, Buffalo, and Washington.

This station recently celebrated its fourth birthday. Culled from the mass of proud statistics that always accompanies such an event are the following facts: WGY broadcast for the first time in this or any other country on 50,000 watts; it conducted a series of experiments using alternately horizontal and vertical radiation (maybe you know what that means—we don't); it perfected successful 250-mile radio relay on 1560 meters. It sometimes speaks with four different voices simultaneously, for its words and music may be picked up on 41 meters, 109 meters, 1560 meters, and 379.5 meters.

THE most interesting thing about the National Broadcast Listeners' League to our mind is the name of the president and vice-president. Introducing: Messrs. Luckey and Yockey!

MANIFESTO issued by KFI:

A positive belief that nothing of musical importance has ever or can ever come from a broadcasting station persists in the minds of certain people, even in the face of the many radio events of 1925 that would do honor to the greatest musical capitals. The instinct to decry and belittle broadcasting is laughably illustrated by the refusal of a Los Angeles music critic to listen, to the recent broadcasting of the complete Los Angeles Philharmonic Orchestra, conducted by Walter Henry Rothwell, on the ridiculous score that the concert couldn't be good if it were given in a broadcasting station. As an example of meritorious programs, KFI, a station representative of many, broadcast in 1925: Ernestine Schumann-Heink, Marcel Journet, Antonio Cortis, the Victor Recording Orchestra, Duci de Kerekjarto, Adolph Tandler's Little Symphony, the San Carlo Grand Opera Company, and other fine organizations and soloists of a more local nature. Compositions of every great composer, modern and classic, were satisfactorily represented and rendered during the year, some of which were rescued from obscurity and introduced to a wide audience for the first time.

To attack broadcasting as an institution because of a percentage of unsatisfactory programs is like attacking literature because of the driveling books which flood the market, or the stage because of the inanities which appear on it, according to Earle C. Anthony, owner of KFI. He finds the bulk of the radio audience intelligently aware of the destiny of radio and content to accept the best efforts of broadcasters without unduly condemning those transgressions of good taste and quality that are primarily a result of the youth of the art.

PROPHETIC utterances by Mr. Powel Crosley, Jr., proprietor of WLW on the occasion of his station's fifth anniversary:

"I can safely prophesy reception of broadcast entertainment eventually from every nation on the globe. The only thing needed now is more power in the broadcasting station. I prophesy moving pictures and radio vision in homes within the next five years. This will be brought about by a vision microphone, set up to catch things you would like to see in various parts of the world—transmitted through a broadcasting station and received in your home on a moving picture screen. Another development that may come within a few years is the transmission of heat and energy by radio."

Willie, turn off the radio—the house has gone up to eighty!

KDKA having got off its chest a series of six weekly talks on public speaking, and a series of seven weekly lectures on "Chemistry and Human Progress" is now engaged in ladling

IN CALIFORNIA

The only important fact not told by the perfectly readable lettering on the portable radio station is that the two standing with possessive air near the door of the "studio" are Charlie Wellman, manager and announcer at KFWB, left, and Frank H. Murphy, chief electrician for Warner Brothers out a "Science in the Home" series every Wednesday night at 8:15.

These educational features come from KDKA's University of Pittsburgh studio. While we are inclined to believe that information gleaned from reading is not as likely to go in one eye and out the other as radio'd information is prone to go in one ear and out the other, still there may be a slight permanent value in these lectures.

At any rate they are presented in an interesting manner, and in every instance by a capable lecturer, thoroughly familiar with, if not even an authority on the subject.

The Spring Science series listed such subjects as these: Food Values, Foods from the Sea, Selection and Care of Beds and Bedding, Fuel Economy in the Home, Home Disinfectants and Insecticides, Selection and Care of Textile Fabrics, Renovation of Wearing Apparel, Care of Tableware and Kitchen Utensils, Selection and Care of Flooring Materials, and so forth.

OUT of consideration for the radio audience of the United States Marine Band Orchestra, the Marine Corps has authorized the draping of the walls of the Marine Barracks in Washington from which the Marine's music is broadcast by WRC, WJZ, WGY. This draping should greatly benefit the acoustic properties of the auditorium and eliminate the slight echoes which have been noted in the past.

PRINTED announcement told recently of a "Hickey Game" to be broadcast by WJZ direct from Madison Square Garden. You may roll your own joke.

WGN is engaged in signing up a body of "official listeners" and now has over 1000 scattered throughout the country. They are expected to offer a regular channel through which worth while information on program and broadcast quality will reach the station, information which formerly had to be culled from the mélange of miscellaneous listeners' letters. Most of the larger stations, we understand, have a staff which analyzes the mail received. The new method makes it possible to grasp worth while information in a much quicker way.

Official listeners are being selected by WGN from points in all sections of the country, and their very distance from the station should be an admirable way of judging reception in their localities. All of the listeners are being furnished with blanks on which space is provided for marking the quality of the program, the volume of the station, for checking fading and objectionable atmospheric conditions.

WOR is presenting as a tri-weekly feature, on Monday, Wednesday, and Saturday evenings, George Tcherban's Katinka Gypsy Orchestra. This band was first formed by Tcherban in Constantinople and only recently came to America. Their work both in the general classic literature of music and in their native Russian and Gypsy airs is very good. To our own dance music they bring their innate sense of rhythm and an individuality of treatment.

WKRC at Cincinnati has built itself a new and very fancy studio in the Hotel Alms. Came to our desk copious pages from WKRC's publicity department foretelling the event and describing the opulent layout in detail. Therein we learned:

"When finished, the studios will be among the most lavish in the country. Here will be found the most artistic furniture from the Italian periods; gorgeous draperies for walls and ceilings. Rich rugs and artists will be engaged to decorate the walls and ceilings.

That last sentence leaves us guessing. We picture, on the one hand, a couple of long haired Persian carpets perched on the giddy heights of a scaffold busily engaged in painting cupids and blue clouds on the ceiling. Or on the other hand: an assortment of artists, neatly ironed out, and secured to the wall by thumb tacks in the manner of cow hides and bear skins. Neither picture is entirely convincing—besides artists aren't rich, even if the rugs are.

ADD to the now imposing list of first string artists who have appeared before the microphone the name of Mary Garden. She was heard, some time ago now, through WJZ. Miss Garden being one of the meager four or five opera singers worth seeing as well as hearing, and being by all odds the first of that four or five, it seemed to this listener a crime to limit her two-dimensional art to the single dimension of radio.

WE ARE glad to note the return of George Barrère's Little Symphony orchestra to WEAF. George Barrère, himself, recognized as one of the world's premier virtuosos of the flute, founded the "Little Symphony" in 1914, when it was called into being at a concert given in New York City for the benefit of the American Red Cross which carried on such important work during the war.

The "Little Symphony" consists of a choir of wind instruments, flute, oboe, clarinet, horn, trumpet and bassoon combined with an adequate balance of the strong section and to the music lover and student offers an unusual opportunity to study the use of the more important instruments. It has often been called "The Miniature Orchestra," for it possesses all the qualities of the full symphony and at the same time a sweetness and subtle charm which is so often lost in a large orchestra.

WHT, Chicago, announces with pride that "if the particular number coming from WHT does not suit your fancy, wait three minutes and another will succeed it." Commenting on this new rule the station's program director said: "It will give the entire program more freshness and more variety. Moreover, the artists themselves are in favor of being limited to three minute selections, which will allow them to play but one number. It will allow them to concentrate on this number and give it "a more intense interpretation," as one of them put it. The only exception to this rule will be special speakers who will sometimes be allowed eight minutes, and dance orchestras who will be allowed about the same amount of time.

Which causes this listener, who has, as you know, ranted on at great length against the "kaleidoscope," program, to throw up his hands in holy horror and erase the letters WHT from his log.

WE KNOW of no concert on the entire Atwater Kent series concerning which we have heard more favorable comment than that of Madame Schumann-Heink. Added to the fact that the famous contralto enjoys the affection of the whole nation, her voice is admirably suited to radio transmission. She succeeded in making felt her personality quite as well as she does on the concert stage.

Another WEAF program that seems to have been greatly enjoyed was the third annual concert of the Associated Glee Clubs. Twenty-six Glee Clubs from New York City and several other cities near by, with a combined membership of 1200, took part. Miss Anna Fitziu of the Metropolitan and Chicago opera companies was soloist. Walter Damrosch directed the event.

THE Victor Hour programs, broadcast at intervals through WJZ, WGY and associates, continue to be *pièces de résistance* on the radio menu. WJZ has inaugurated the broadcasting of the Saturday morning (11 A. M.) Children's Concerts of the Philharmonic Society of New York from Aeolian Hall. And we trust they are being occasionally listened to, though the hour is most unseemly.

HOWARD THURSTON, the magician, has succumbed to the lure of radio, and filled a first engagement recently at WLW. Thurston is gratified at the success of transmitting photographs and the human voice through the air, and makes prediction that it may be possible to broadcast human beings—the dream of many scientists and inventors. Experiments are being

ADOLPH SCHOTTLER AT WAHG

A well known soloist on the bass viol. Mr. Schottler and his accompanist, Mita Weinzoff, composer-pianist, are frequently heard on Saturday afternoons over WAHG

RALPH FREESE

One of the announcers at KOA, Denver. Listeners to this station, in their correspondence, have hazarded guesses as to his personal appearance. Although his voice is low and mellow, he is not "tall and thin" as one letter-writer assumed. He is a lyric tenor and not a basso. The microphone voice, it may be added, is most deceiving

conducted by Thurston along the lines of broadcasting a human form through space. He carries some apparatus with him and has a greater part of it in his laboratory at Beechurst, Long Island.

We have a boundless faith in Mr. Thurston's ability to do any thing he pleases, and hereby earnestly entreat him to cease his experiments. Imagine the unwelcome shock of having your most hated announcer suddenly start to trickle through the loud speaker, jump lightly to the parlor floor and shout brightly "Well, here I am folks!"

WHAZ, the Rensselaer Polytechnic Institute station at Troy, New York, sends out a good program Monday evenings (its only time on the air). These programs are semi-highbrow in nature, well done, and prone to specialize in music's "best sellers."

AFTER all is said and done, it is the regular weekly features that constitute the best that radio has to offer. The various So-and-So Hours set a definite standard for themselves and attempt to live up to it. They use none but paid labor and come around every seven days at a fixed hour which makes them easy to locate. They maintain a more or less uniform type of program, so the listener knows what to expect. Those "Hours" you dislike you can carefully skip; those you like you can count on. So clearing our throat and noisily tipping over the gilded banquet chair, we arise and take this occasion to welcome the new Bakelite Hour, from WJZ, eight to nine P. M. Sunday nights.

WHEN in need of jazz try WSM, Nashville, Tenn., Monday, Wednesday, Friday, or Saturday nights between 6:30 and 8. Francis Craig holds forth at this time with his prom trotting band, and of them this eulogy, largely deserved, has been written: "They strike a happy medium between the spiritless, phlegmatic style of the mechanists whose souls are unmoved by syncopation, and the slam-bang, ear-splitting squawks of the amateur gatherings whose ecstasy resembles too closely idiocy, and fill the air with soft, tantalizing sounds of amazing sweetness."

Another jazz band that titilates our tympanum is Paul Specht's Original Orchestra which WJZ picks up from the Moulin Rouge in New York. They're good, in spite of the fact that they ponderously label themselves "rythmic, symphonic, syncopators."

WGBS, ever faithful in tapping New York's theaters for what they may have, did a good job recently of broadcasting the "Charlot Revue" from the Selwyn Theater—as good, at least, as such pick-ups ever are. When a sketch came on the boards that couldn't be intelligibly listened to without aid of vision WGBS switched to its studio and filled in the interval.

THE KGO players, when last tuned-in, were engaged in the weighty task of broadcasting Sir Edward Bulwer Lytton's "Richelieu." Wilda Wilson Church, director of this organization, had her hands full, what with directing a cast of sixteen players. Considering the size of the cast, the length of the play (five acts), the fact that it wasn't written by Sir Edward for the radio, and likewise considering our usual hostility to radio plays, it was well done!

CHICAGO, every now and then, crashes through with something good. Jacques Gordon, violinist, offered a series of concerts through WGN that were especially fine. Mr. Gordon is concertmaster of the Chicago Symphony Orchestra and enjoys a well earned renown. He plays, if it be of interest, a Stradivarius violin called the "Clara Schumann Strad," which once belonged to the wife of the famous musician of like name.

WBAL has been broadcasting a series of "Musical Scenarios" that have proved an interesting novelty. They are arranged by Broughton Tall, musical writer and dramatist, and a member of WBAL's staff, and are narrated by Harry Welker.

The first of the series was "The Evolution of American Popular Song." It traced the history of song in America from the days of the Revolution, 1776, when "Yankee Doodle" was the popular piece of the day on down through the many "periods" that have featured the centuries, concluding with George Gershwin's famous "Rhapsody in Blue."

America's song history, as presented by Mr. Tall's scenario, is intriguing, to say the least. Following the vivid, colorful Colonial period when lovely crinolined ladies in powdered wigs flirted over lace fans with velvet clad gallants, on through the war of 1812 with its "President's March," the slave songs that have colored many later important musical works, until in 1850 we come to Stephen Foster's quaint songs, including "Massa's in de cold, cold ground," "I Was Seeing Nelly Home," and other pieces that had a great vogue during the days just prior to the outbreak of the Civil War. This conflict brought "Tramp, Tramp, Tramp, the Boys Are Marching" and then came the Southern songs, "Dixie," "Old Oaken Bucket," "Silver Threads Among the Gold," etc.

AT KSL, SALT LAKE CITY

State Senator Herbert S. Auerbach is shown feeding Teddy Grizzly Bear after his (the bear's) broadcast over KSL. At KSL, they say that the bear's broadcast was highly popular with listeners, although how the deuce the grizzly could be distinguished from thunderstorm static, we don't claim to say

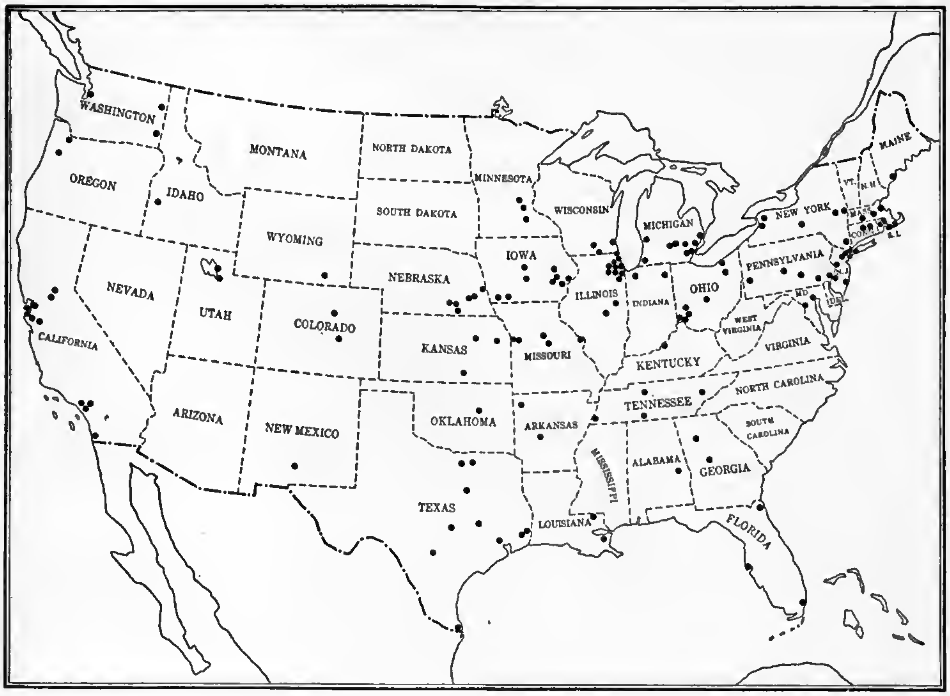
Continuing, the scenario depicts the days of Tony Pastor's theatre which made famous "Rosie O'Grady," and "On the Banks of the Wabash." And then we see George M. Cohan's cake-walk, the two step, and hear "It's a Grand Old Flag." The Spanish war ushered in another patriotic "period" punctuated by "Good-by Dolly Gray," "There's a Hot Time in the Old Town To-night"; came next such songs as "In the Good Old Summer Time," "Wait Till the Clouds Roll By," "Back, Back, Back to Baltimore," "In the Shade of the Old Apple Tree."

Finally, we come to the modern song period illustrated by Irving Berlin's "Alexander's Ragtime Band" and later, the outburst of patriotic songs—"Over There," "Joan of Arc," etc.—that accompanied the World War which led directly to the jazz period of which George Gershwin's "Rhapsody in Blue" is perhaps the most serious and noteworthy contribution.

AN INTERESTING item on WLW's programs is the Burnt Cork Review. This is an organization of instrumentalists, singers and comedians, who provide an hour of favorite songs and stories Tuesday evenings at eight o'clock. Louis John Johnen, director of the station, is interlocutor.

KGW, the *Oregonian*, at Portland, Ore., will install a 1000-watt broadcasting station of Western Electric manufacture, to replace the 500-watt equipment now in use. The station with its new equipment will probably be ready to go on the air about the middle of April.

"UNCLE JOHN," OF KHJ, LOS ANGELES



WHERE THE LOCAL RECEIVER WILL BE MOST EFFECTIVE

The dots indicate locations in the United States which have broadcasting stations of at least 500 watts power. The set described in this article should be most effective in at least a twenty-five mile radius of the dotted localities

The "Radio Broadcast" Local Receiver

Constructional Details for a Simple Five-Tube Receiver Designed Specifically for Local and Not Distance Reception with the Highest Quality of Reproduction as a Goal

By JOHN B. BRENNAN

WHEN the radio constructor considers the building of a radio receiver sometimes he is after distance reception, sometimes merely to putter around, but nine times out of ten what is really desired, whether seriously considered or not, is good quality of tone from the loud speaker. It is surprising too, to note the increasing number of people with five-tube sets sold to them for their wonderful distance qualities, listening with much satisfaction to the local program.

All this points in a certain degree to the prominence of the local station in the life of the American citizen. In reception he wants quality. His local station, because it is local, is more apt to supply it than a station at a distance.

No elaborate receiver is needed to bring to his home the quality of music and speech to which he would like to listen. There are several requirements that must be fulfilled. The receiver must be turned on and off without disconnecting wires; it must have a dial to tune from station to station, and lastly there must be a volume control. Simplicity itself.

The receiver described here fits in very nicely with these requirements, having been designed to embrace these general specifications. Five tubes—one tuned radio-frequency amplifier, a regenerative detector, a transformer audio amplifier, and two stages of resistance audio amplification—insure for the receiver a suitable signal pick-up and tone amplification that puts it in a class where tone quality and simplicity of tuning are prime requisites. The tuning of the radio frequency and detector stages is obtained by employing a "gang" condenser—one with two stator sections insulated from each other and a common section of rotor plates.

To suppose that in a home-made receiver the tuning points for both tuning condensers would be exactly the same would be too much. Even assuming that both tuning coils have the same number of turns of the same size wire, the chances are that the connections from coil to condenser to tube socket would not be the same for each tuned circuit and accordingly would introduce differences in the value of each circuit sufficient to cause a detuning effect. This effect would manifest itself in such a way as to prevent a signal, impressed on the grid of the first tube, from being passed along to the second tube.

To offset this possibility of difference in tuning for each tuned circuit, that section of the duplex condenser which tunes the detector circuit is shunted with a midget condenser to serve as a vernier adjustment and allows both circuits to be brought into resonance with each other. Many may prefer to employ this midget condenser as an auxiliary volume control when exceptionally strong locals are being received.

The output of the detector is passed along into an audio transformer purposely designed for high quality amplification. By its use, a greater

RADIO BROADCAST Photograph

FIG. 1

First appearances and impressions often deceive. The dial located in the center of the panel, viewed here, is used as the main tuning control. The others do not complicate the operation of the receiver, that to the right being a volume control and that at the left, an auxiliary tuner amplification in signal is gained than if all resistance amplifier stages were employed.

THE AUDIO CHANNEL

TWO resistance audio amplifier stages follow the transformer amplifier stage and in the last socket, a type 112 tube provides an efficient power amplifier, necessary properly to operate any good horn or cone loud speaker.

On this last stage, the plate voltage is 135 with a grid bias of 9, or 180 volts with a grid bias of negative 13.5, or 225 volts with a negative 18 volts bias. On the first two audio and the radio stage, the plate voltage is 90. For the detector, 45 volts will be found suitable. At least nine volts C battery is necessary for a 112 tube and not more than three volts should be applied to the grids of the first two audio amplifiers. Where greater volume is desired from the receiver, the B battery voltage for the radio frequency stage should be increased to a point just below where the r. f. stage will oscillate.

All the filaments are in parallel and are controlled by one filament ballast so designed that it will pass $1\frac{1}{2}$ amperes of current and allow 5 volts on the filament terminals. Those satisfactory for this purpose are the Brach, the Elkay, the Amperite, and the Daven filament ballasts. Where one ballast of the correct size is not obtainable, any two that total $1\frac{1}{2}$ amperes may be employed in parallel, or a separate ballast may be used for the 112 tube.

From Figs. 1 and 2, the panel layout will be seen to be quite simple. The large dial in the center commands immediate attention and is the main tuning control. To its right is the volume control, otherwise the regeneration control, and at the left end of the panel the vernier tuner, sometimes used as an auxiliary volume control is located. Filament switch and loud speaker jack are placed to either side of the main tuning dial and directly below it.

Inside the receiver the audio amplifier tubes are arranged along the back edge of the baseboard while on either side, and to the rear of the tuning condenser, which is the central object, are placed the two sockets, one for the radio stage, the other for the detector. The two tuning coils are directly behind the condenser and between the two tube sockets.

It is obvious that, in a receiver of this kind, where one condenser control adjusts two tuned circuits, these two circuits must be very similar in electrical and physical dimensions so that as the condenser plates are rotated, the two circuits keep in step with each other over the entire scale of the dial. An approximate similarity is the most that can be hoped for in the coil units, and any slight difference is compensated for in the vernier condenser adjustment. To make coils that are similar is the immediate problem.

The Facts About this Receiver

In the circuit diagram, Fig. 6, the values of the lettered parts are:

C1—.000375 mfd.	C6—.002 mfd.	R1—.665 ohms (to pass $1\frac{1}{2}$ amps)
C2—.000375 mfd.	C7—.00025 mfd.	R2—3 megohms
C3—.000016 mfd.	C8—.1 mfd.	R3—100,000 ohms
C4—.00025 mfd.	C9—.1 mfd.	R4—1 megohm
C5—.002 mfd.	L1 } Construction de-	R5—100,000 ohms
	L2 } scribed in text.	R6—1 megohm

The other parts used in the model built in the Laboratory are:

1 Marco Vernier Dial
1 Panel 7" x 18"
1 Baseboard 12" x 18"
1 Open circuit jack
1 Filament Switch
5 Sockets
1 Rauland Lyric audio transformer
9 Binding Posts or Fahnestock clips
Miscellaneous: screws, brackets, wire, etc.

OTHER PARTS THAT MAY BE USED

Tuning Condensers	*Audio Transformers*	*Resistance Coupling Units*	
Gardiner-Hepburn	Rauland-Lyric	Daven	Muter
Bremer-Tully	Pacent Superaudioformer	Mountford	Brach
U. S. Tool	Federal	International	Electrad
Hammarlund	Erla Concert-Grand	Amsco	Aerovox
Lombardi	Amertran De-Luxe		
Bruno	Thordarson		

TUBES

R. F. and Detector	*1st and 2nd Audio Stages*	*Last Audio Stage*
201-A	201-A	SEMI-POWER TUBE SUCH AS 112
199	or	or
	HIGH-MU	W. E. 216-A

DETAILS OF THE COILS

ON A piece of bakelite or cardboard tubing $3\frac{3}{4}$ inches long and $1\frac{1}{2}$ inches in diameter, 105 turns of No. 28 d. c. c. wire are wound, the first turn starting $\frac{3}{4}$ inch in from one end. See Fig. 3. This end connects to the grid of the radio frequency tube and to those stator plates of the two-gang condenser that are to be used for the radio frequency stage. The last turn is common to both ground and negative A battery line and also connects to the rotor shaft of the two-gang condenser. Twenty turns from this end, a tap is taken which connects to the antenna post. At the grid end of the coil a $\frac{1}{2}$-inch brass angle piece is

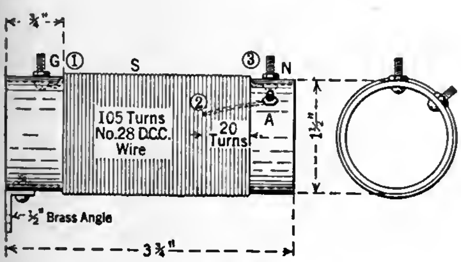


FIG. 3
The construction of the antenna coil unit is fully shown here. Cardboard tubing may be used to wind the coils, but hard rubber or micarta tubing is more to be desired

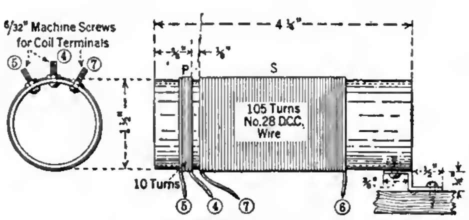


FIG. 4
The detector coil unit is quite similar to the antenna coil unit except that a plate coil is provided. The numbered terminals coincide with the connection shown in the circuit diagram, Fig. 7

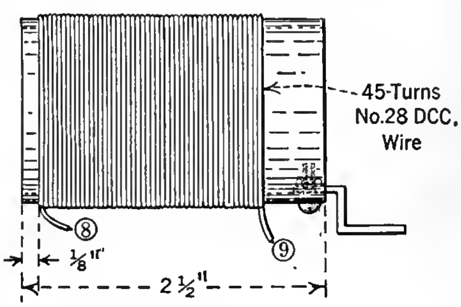


FIG. 5
The tickler coil is wound on the same size tubing as the antenna and detector coil units. It is supported by a small brass bracket similar to that supporting the detector coil unit

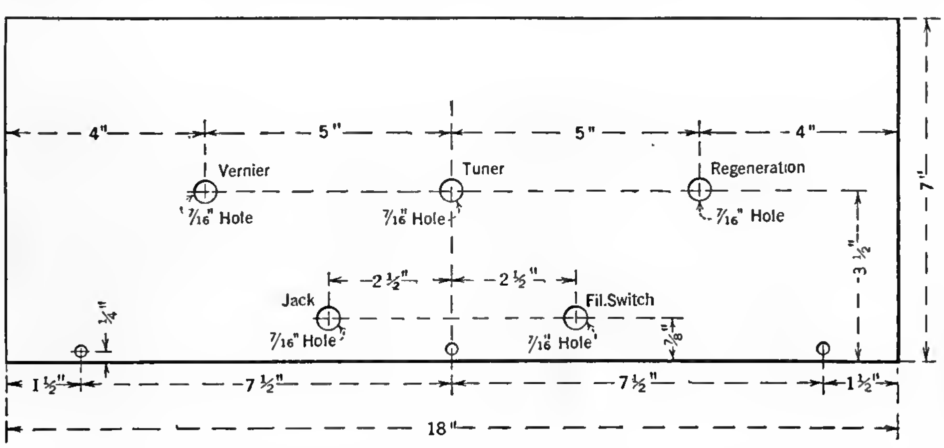


FIG. 2
In this panel layout the main mounting or shaft holes are all of the same size, i. e., $\frac{7}{16}$". The holes through which are passed the wood screws which fasten the panel to the baseboard are drilled with a No. 18 drill and countersunk if flathead screws are used. The actual mounting holes for the condensers are not shown as their positions will differ for the several types of condensers which may be employed

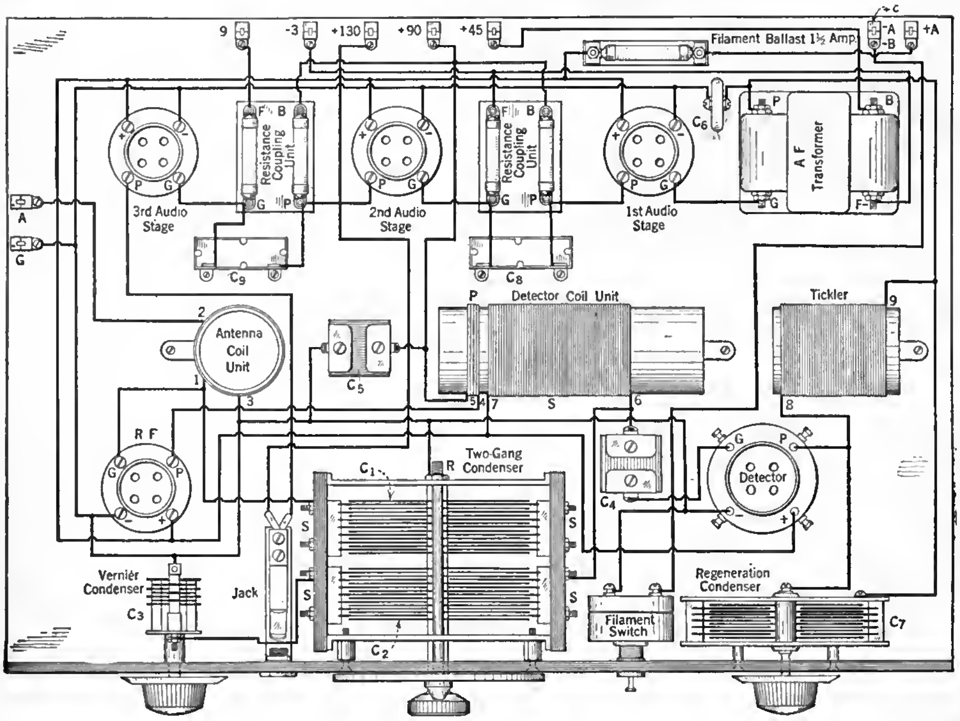


FIG. 7
This illustration, besides showing the actual wiring of the receiver, shows the placement of all the parts and makes the job of assembly and wiring quite simple

fastened by which the coil is mounted in place on the baseboard.

The same diameter tubing is used for the detector coil unit and tickler coil shown in Figs. 4 and 5. For the former, 10 turns of the same wire are wound, the first turn beginning $\frac{5}{8}$ inch from one end of the tubing. In the sketch Fig. 5, the dimension $\frac{5}{8}$ inches indicates the space from the edge of the coil form to the last turn of the 10-turn coil. This should show the $\frac{5}{8}$-inch space from the edge to the first turn. After the ten turns have been wound the wire is cut and an $\frac{1}{8}$-inch space is left between this coil and the first turn of the next winding which is the detector secondary. The first turn of the ten-turn coil, otherwise the plate coil of the radio-frequency amplifier, connects to the B+90 terminal. The last turn of this plate coil connects to the plate of the r. f. tube. The first turn of the secondary connects directly to the positive terminal of the detector socket and *does not* connect to the condenser as usual. One hundred and five turns are also wound for this secondary, the last turn connecting to the grid leak and condenser and also to the stator plates for the detector.

The tickler coil consists of 45 turns of the same wire wound on the same diameter tubing $2\frac{1}{2}$ inches long. It is fastened to the baseboard by a brass angle piece in the same manner as

RADIO BROADCAST Photograph

FIG. 8

This shows clearly the type of duplex or gang condenser used in constructing the local receiver. Two sections of stator plates, insulated and opposite from each other, and one shaft having two sets of plates thereon make up this condenser which is employed simultaneously to tune the antenna and detector circuits

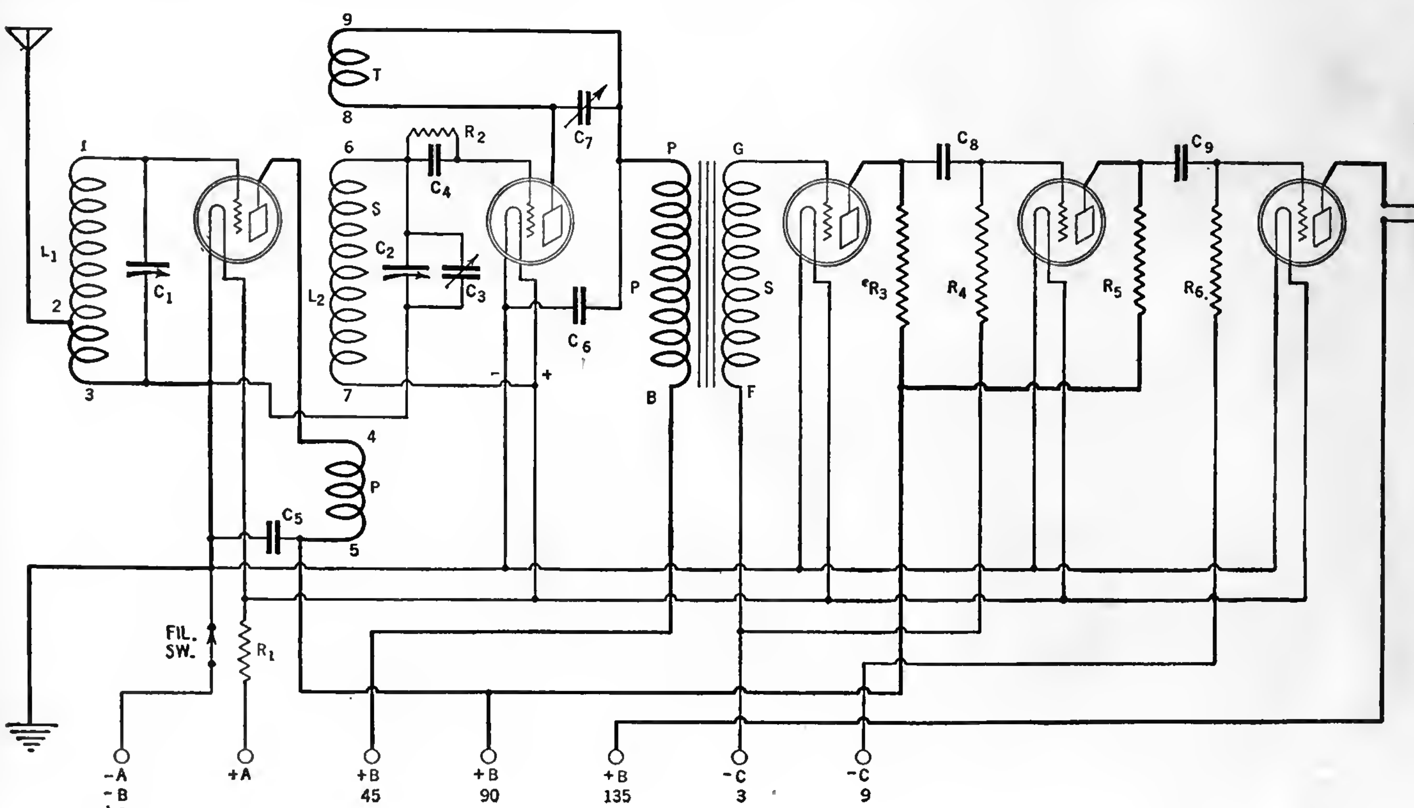
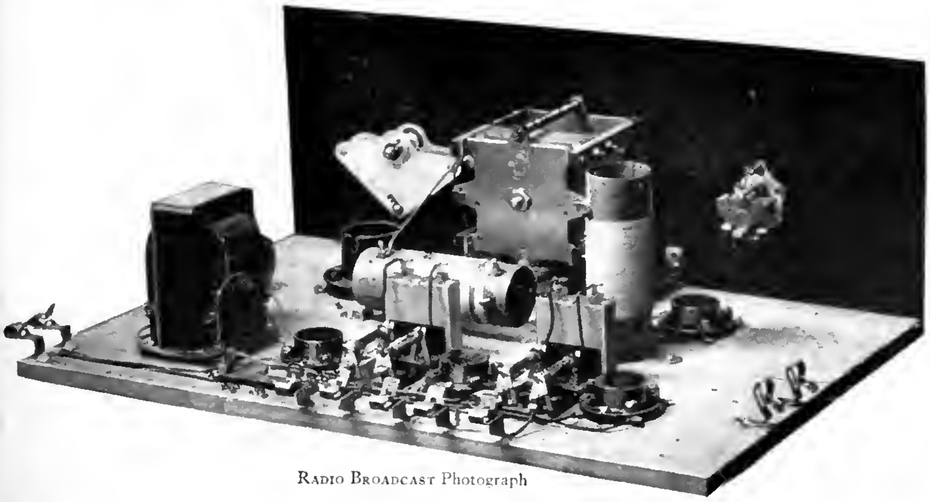


FIG. 6
The circuit diagram for the Local Receiver is not complicated, although there are several features involved that are somewhat new. The values for the various parts are contained in the text



RADIO BROADCAST Photograph

FIG. 9

A general view of the local receiver partly wired. To the ingenious and energetic set-builder the possibilities for making use of a sub-panel assembly are evident

the detector coil unit. This coil is wound in the same direction as the turns on the detector coil unit.

Small holes drilled into the tubing with a No. 57 drill allow the constructor to pass the coil end-leads down through these holes and through the center of the tube to several 6-32 machine screws which have been previously fastened at the end of the tubing to act as terminals. This facilitates wiring and insures against breaking delicate coil wires.

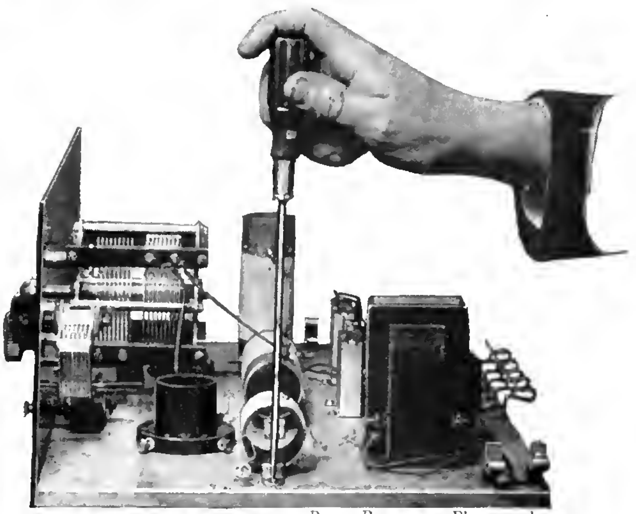
The peculiar connections of the return side of the detector secondary are evident from a glance at the circuit diagram for the receiver in Figs. 6 and 7. For proper detection it is better that the return side of the detector secondary be connected to the positive filament terminal of the detector socket rather than to the negative. Since for a radio-frequency amplifier, the opposite holds true, then if the rotor shaft of the gang condenser, which is common for both condenser sections, be connected to the negative side, it is not possible to connect the detector return to the rotor shaft and to the positive side of the filament terminal because such a procedure would cause the A battery to become short-circuited. Therefore, this difficulty is evaded by connecting the return side of the detector secondary not to the rotor shaft but direct to the positive terminal of the detector socket.

A TUNING CHART

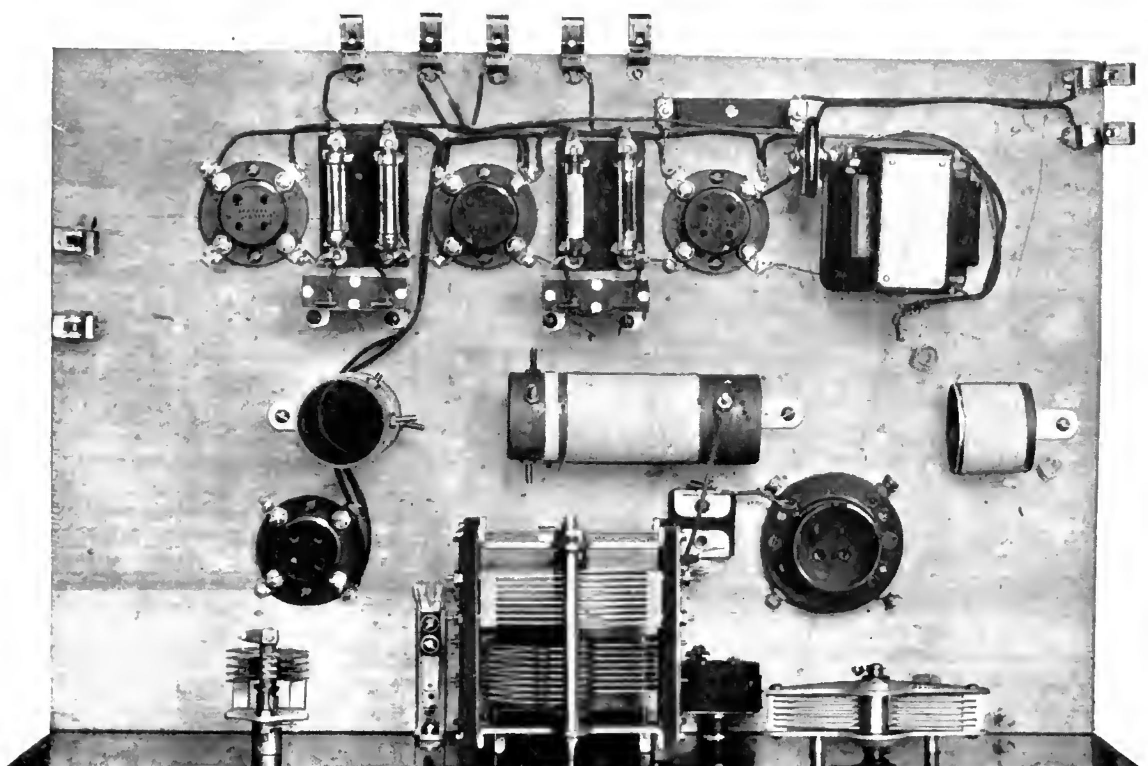
AFTER the receiver has been assembled and wired it is worth while in operating it to prepare a chart or curve to enable the operator to tune to stations without having to fish for

FIG. 11

If the detector oscillates too violently the tickler coil may be turned on its pivot screw so that its turns are at right angles to those of the detector secondary. The photograph here incidently shows the line up of the coils to minimize inter-coupling effects



RADIO BROADCAST Photograph



RADIO BROADCAST Photograph

FIG. 10

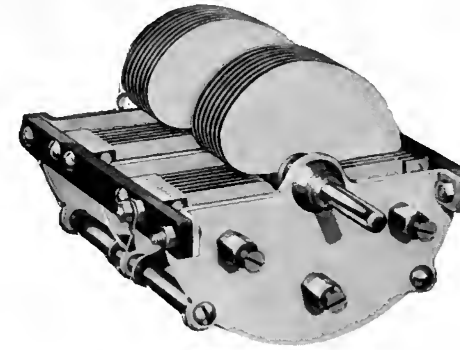
Cross reference and comparison with this and the other photographs accompanying this article make the understanding of the assembly and disposition of the parts not difficult. A wider base-board than those usually employed in receiver construction makes the wiring and assembly easy

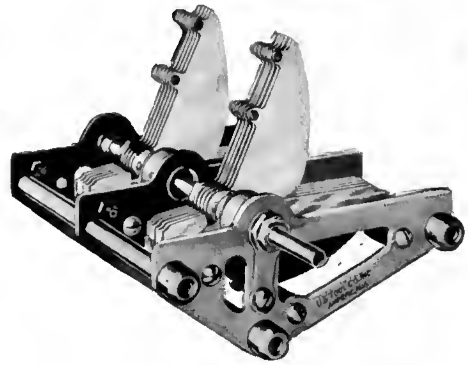
FIG. 12

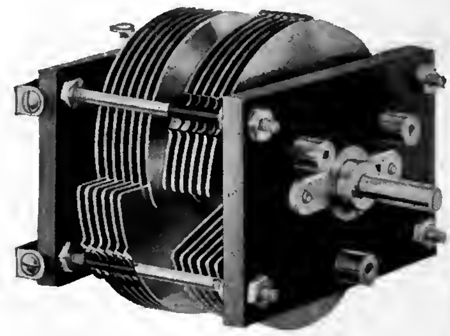
Several types of gang condensers which are used for simultaneously tuning several grid circuits. Directly below is the condenser manufactured by the Lombardi Company —that at the lower center is the product of the U. S. Tool Company

FIG. 13

Two more gang condensers, the Gardiner Hepburn to the left, above, and the General Radio directly below add to the many makes of condensers of this type which may successfully be employed in the receiver described







them. Several minor adjustments on the inside of the receiver may be found necessary, to make it function satisfactorily over the entire wavelength range before this chart can be prepared. For instance, if the detector oscillates violently, the tickler may be swung on its pivot so that the direction of the turns are at right angles to those of the detector coil unit. If this does not suffice, then turns should be removed from the tickler coil until a satisfactory point is reached where the receiver will not oscillate at the lowest position on the main tuning dial, with the rotating plates of the regeneration condenser turned fully out.

The coil specifications given apply when a two-gang tuning condenser is used whose sections are each .000375-mfd. capacity.

The condenser employed in the construction shown here is the Cardwell type 217B. Other makes that may be used are listed in the Parts List.

Of course, other values of condensers, too, may be employed for the tuner unit. If its capacity is greater than that specified above, then it will be well to wind the same number of turns as specified, and on both coil secondaries simultaneously reduce this number, the while making tests on the receiver, until the highest wavelength which one desires to receive is located on a high point on the dial. For this test it would be simpler to connect the antenna and ground to the plate coil and disconnect the radio-frequency amplifier from any B battery leads to prevent short circuits. Then by tuning-in on the detector alone, the approximate coil turns for the particular condenser employed may be found by the cut and try method described. Once the proper number of turns for the detector coil is determined, the same changes may be made for the antenna coil unit and the receiver re-connected as shown in the circuit diagram. Where a condenser is employed whose capacity is lower than that stipulated, more turns will have to be wound on the coil form than the 105 turns which are satisfactory to cover a tuning range from 545 kc. (550 meters) to 1500 kc. (200 meters). However, for single control of this nature it is unusual to employ very small condensers due to the corresponding increase in the size of the coils necessary in such an arrangement.

Volume is controlled by the regeneration condenser, but at no time should this adjustment be advanced to the point where the receiver oscillates. In such a position clear reception is impossible for the listener. To prevent radiating disturbing squeals, the plate voltage to the r. f. amplifier should not be made so high that the r. f. stage will oscillate.

Very little explanation is necessary for the audio amplifier unit. In the position as shown, exceptionally short grid and plate leads are obtained, and it is possible to cable the B battery and filament leads so that there is little chance for large closed loops so detrimental to the proper operation of a receiver.

For tone quality, the use of a type 112 tube in the last stage is absolutely essential. It is only necessary that at least 135 volts of B battery and 9 volts of C battery be applied to this tube for distortionless reproduction.

The Short-Wave Receiver Contest

AMONG many interesting points that have come up in connection with the Radio Broadcast-Eveready contest for a non-radiating short-wave receiver, there are several that seem to be particularly worthy of mention.

In the first place, the contest closed April 1 after an extension of one month had been made to enable foreign receivers to arrive in Garden City in time to be judged with those produced in this country. Interest was awakened in England by announcements in *Popular Wireless* that such a contest was waging in America so time had to be allowed for European entries.

Many manuscripts have been received. Some of them obviously cannot be considered, for they describe nothing but the ordinary Reinartz circuit which seems to be used in about 90 per cent. of present short-wave amateur stations. Several others used foreign tubes, or devices that no one could purchase or build without extensive gear and one of the conditions of the contest was that standard apparatus was to be used.

All receivers in the Laboratory by March 8th were exhibited at the Second District annual Convention and Radio Show at the Hotel Pennsylvania, New York City, March 8-13, where they attracted considerable attention. This was but natural, since it was the first time that a new series of short-wave receivers had appeared since the Reinartz capacity feedback circuit. For years the "ham" has used this circuit which has proved to be sensitive and easy to handle, but a persistent feeling has been in the back of his head that somewhere there might be an improvement on the old faithful.

In fact this contest was started with just that idea in mind, to find out if the regenerative tube working directly from an antenna was the best possible receiver for short waves, and to ascertain if there was not some simple means of preventing the oscillations from such a detector from getting out into the ether.

Radio Broadcast has always frowned on receiving circuits that were liable to disturb nearby listeners, and this meant "thumbs down" on the familiar Reinartz and its cousins. For that reason the Editors have refused to publish complete details on such receivers, feeling that it would be folly to entice the many Radio Broadcast's readers into the short-wave bands with receivers that would contribute to the squeals and howls on the short-wave channels.

Now it is not the purpose of this announcement to state who won the prizes, for that has not as yet been decided nor are any of the secrets of the circuits used to be given away here. There will be given in the July issue after the judges have had time to go over each contestant's manuscript and to listen to his receiver compared with all of the others.

Trickle Chargers for Your A Battery

Installing and Using the Commercial Types—How to Make an A. C. Trickle Charger—The Circuit for Trickle Charging from a Direct Current Supply—Care and Use of the Storage A Battery

By JAMES MILLEN

THE trickle charger method of maintaining the storage A battery of the receiving set in a charged state is not the final answer to the problem, but it is a highly convenient and usually simple method and one which has found wide favor. This unusually complete article describes the commercially available types and also gives constructional details for making one's own charger. The trickle charger is about as efficient electrically as the standard, full-rate types with this added advantage, that it maintains the battery more nearly charged constantly and so is better for the storage cell. Care should be used lest the battery fall below the point where it cannot be brought up by the trickle charger. The charger in some instances can be used while the set is in operation, but, that is not always possible.—The Editor.

EVER since the advent of the radio B current-tap devices, there has been what appears to be a fairly insistent demand by the public for the elimination of the A battery. The tube manufacturers brought out dry-cell tubes to do away with the storage A battery but it was not very long though, until the dry cells were being replaced in many instances by storage batteries.

The storage batteries first used for radio work were merely automobile batteries. No thought had been given by the manufacturers to make them spray-proof and neat in appearance. To-day, however, radio A storage batteries have been developed to the point where they may be placed permanently inside the radio cabinet itself without any danger of corrosion due to acid spray when charging. And now some manufacturers are going so far as to build charge indicators right into the battery so that its condition may instantly be observed at any time without the inconvenience of an acid-dripping hydrometer.

Then improved noiseless and economical chargers were developed which made it merely necessary to turn a switch at night and in the morning practically all the energy that had been drawn from the battery in the preceding week was replaced. But still some of the public was not satisfied, so the trickle charger was developed. Now we do not even have to think about letting the regular charger run overnight once or twice a week. By means of special switches, the trickle charger runs night and day, whenever the set is not in use, so that the small storage radio A battery is always in the best of electrical condition. The next step was to combine the special switch, trickle charger and special spray-proof storage battery into a neat and compact unit that could take its place along side of the B substitute on the shelf under the radio table in the living room.

WHAT THE RADIO POWER UNIT IS

REDUCED to its simplest terms, the radio power unit part of which is shown in Fig. 1., is a storage battery of low capacity directly connected to an efficient charging device which is kept at all times connected to the ordinary house current. A compact metal housing, finished in a rich mahogany color, accommodates both battery and charger, making a most attractive unit, that will fit in the space provided for the average battery equipment. It must be remembered that the storage battery used in one of the new radio power units receives altogether different treatment than the regular storage battery. Ordinarily there is an advantage in using a battery of large capacity. It means fewer recharges. A 100-ampere-hour battery, for instance, will heat the filament of a tube which consumes one ampere, for 100 hours before it needs a recharge. Or it will supply current to four one-quarter ampere tubes for the same length of time.

Except when the receiving set is actually in use, this battery is being charged at a low rate, technically known as a trickle charge—normally sufficient to replace what has been withdrawn from the battery, yet insufficient to harm it.

NEW TYPE OF BATTERY USED

THE small batteries used in radio A power units of this type have been especially designed for the purpose. An unusually large space is provided above the tops of the plates for excess electrolyte to compensate for that lost by evaporation and charging. In these cells it is only necessary to add water three or four times a year.

The rectifying or changing over of the usual alternating house current to direct current (necessary in charging a battery) is accomplished by means of a rectifier tube of the Tungar type, in the power units made by Exide and Philco. Tube rectification is quiet in operation and causes no electrical interference with other receiving sets in the neighborhood.

FIG. 1
A commercial unit for trickle charging. The Exide A Power Unit contains a .2-ampere Tungar type trickle charger

Fig. 2 shows the Gould A power unit. This unit employs a trickle charger of the Balkite type instead of the Tungar tube as used in the Exide radio A power.

The special switch is not mounted on the case of the unit but provided with a flexible extension cord so that it may be conveniently placed on the table alongside of the radio set.

Provision is made so that this switch also controls the B supply unit when such a device is employed.

Water must be added to both the storage battery cells and the rectifier cell about every two months. The electrolyte in all cells is dilute sulphuric acid and, in the action of the Unipower, water is evaporated. Distilled water only should be used to replace it. If the user fails to add water when necessary, the Unipower will cease to charge until water has been added.

Still another unit of this general type is shown in Fig. 3. These units may be obtained with either the tube type or aluminum anode chemical rectifier type of trickle charger.

Many radio set owners who now have storage batteries may obtain the advantages of the A power supply units just described by the use of a trickle charger and "master" switch.

The Balkite trickler charger and Brach control switch make a very fine combination that is economical to operate, low in first cost, and without renewal costs. The average operating cost is but one tenth of a cent per hour.

CARE OF THE TRICKLE CHARGER

THE only attention the Balkite trickle charger requires is the addition of water to replace that evaporated from the electrolyte by the gassing action. It is very important that the cell be maintained with sufficient liquid. It should not be permitted to fall below the low level mark indicated on the cell (Fig. 4). When adding water, fill to the "high" level as indicated. Distilled water is preferable, but if this is not available, any pure water may be used. Water from melted ice or clean snow is good.

The charging rate of any trickle charger for radio use must be adjusted so that over a given period of time the charger will return to the battery an amount of electrical energy equal to that withdrawn from the battery by the radio set, plus from 20 per cent. to 30 per cent. in addition, to compensate for the internal losses in the battery. Thus the rate of charge needed will depend upon the kind of tubes used, their number, and the number of hours per day, week, or month that the set is used. For example: A set using five 201-A tubes is operated on the average of twenty hours per week. As each 201-A tube draws $\frac{1}{4}$ ampere, the total number of ampere-hours withdrawn from the battery per week is $\frac{1}{4}$ x 5 x 20 or 25 ampere-hours. The number of ampere-hours that must be returned to the battery each week, including internal battery losses, is 25 x $\frac{100}{75}$ or about 33 ampere-hours. As the battery is in use for twenty of the 168 hours in each week, the 33 ampere-hours will have to be returned to the battery in 148 hours at the rate of about .225 amperes.

As it is extremely difficult to estimate to just what use any given set will be put, it is a good plan to look occasionally at the charge indicator in the battery (if it has one) and note whether or not the battery is being kept up to charge. A regular hydrometer will give the indication desired if the cells have no built-in indicator.

FIG. 3
The Philco A Power Units are made in two different types. One has a Tungar trickle charger and the other an electrolytic trickle charger

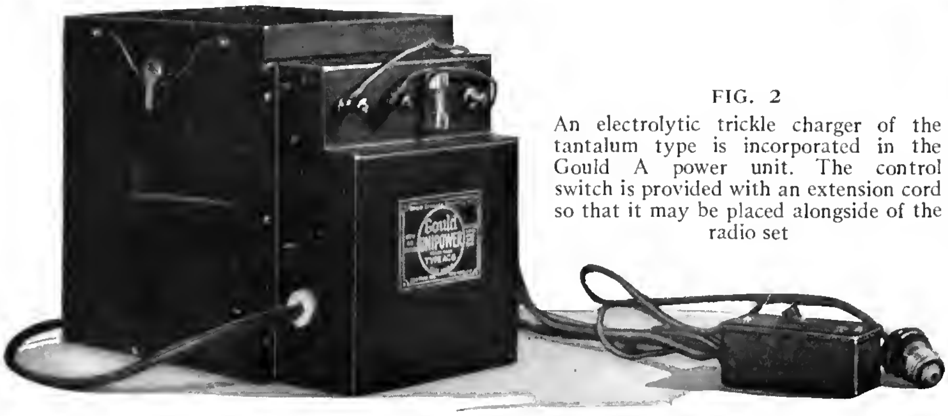


FIG. 2
An electrolytic trickle charger of the tantalum type is incorporated in the Gould A power unit. The control switch is provided with an extension cord so that it may be placed alongside of the radio set

If they are not fully charged, then slightly increase the charging rate. Likewise, if you think the battery is being overcharged, slightly decrease the charging rate. This latter operation although advisable, is not essential as the charging rate is so low in any event that the battery will not be harmed by over-charging.

Provision is made in the complete A power units such as the Gould and the Philco so that the charging rate may be readily varied. There are two general ways by which the charging rate of the Balkite trickle charger may be varied. A resistance may be inserted in one of the 110-volt primary leads or in one of the low voltage charging leads from the charger to the battery. The most convenient resistance to put in the primary circuit is an ordinary electric lamp. This lamp can most easily be placed in the circuit by cutting into the lamp cord from the charger and connecting a socket as shown on Fig. 5. The proper lamp to use under different conditions may be determined from Table A.

It is recommended that only a lamp resistance be used in the primary circuit, and in general a resistance connected in the secondary is preferable. Resistance is connected in the secondary circuit between the charger and the battery as shown in Fig. 5. The proper value of resistance to obtain the charging rate necessary for any certain number of tubes, can be obtained from Table B.

A good 25-ohm filament rheostat having a current carrying capacity of $\frac{1}{3}$ ampere (300 mils.) or more makes a very handy unit to use for resistance in the secondary. The number of ohms of resistance placed in the circuit by such a rheostat can be figured from the portion of the rheostat winding that is cut in. For example, if the contact arm of the rheostat is moved around halfway from the "full on" position, half of 25 ohms, or 12$\frac{1}{2}$ ohms, will be cut in.

Any such resistance should have enough current carrying capacity so that it does not become heated to the point where it might ignite any inflammable material coming into contact with it.

Many readers, however, prefer to make the complete charger. Tantalum, the valve metal employed in the Balkite trickle charger is not obtainable in small quantities, so the construction of a chemical trickle charger of the lead-aluminum type will be described. A home-constructed charger of this type, if carefully made from good materials will give very satisfactory results. It will, however, require more attention than the commercial chargers of this type. Two or three times a year it will be necessary to clean the electrodes and change the solution. Distilled water must also be added occasionally unless a very large jar is employed for the rectifier. The frequency with which water must be added and replacements of solution made will depend very largely upon the charging rate employed. The correct charging rate in turn depends upon the type and number of tubes used in your set.

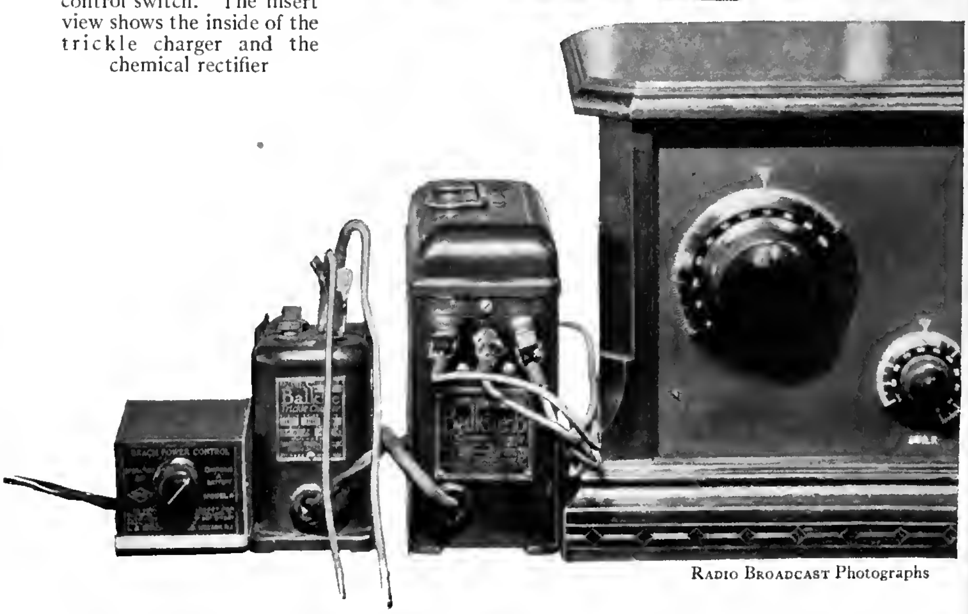


FIG. 4
The Balkite trickle charger enables any one to use his present A battery as a power unit. The photograph shows Balkite B Supply, trickle charger and Brach power control switch. The insert view shows the inside of the trickle charger and the chemical rectifier

RADIO BROADCAST Photographs

TABLE A

The size lamp to be connected in series with the primary leads of a Balkite trickle charger as shown in Fig. 5.

Size of Lamp in Watts	10	25	40	50	60	75	100	none
Rate of Charge 4-Volt Battery	.11	.25	.34	.39	.44	.49	.52	.52
Rate of Charge 6-Volt Battery	.09	.20	.27	.32	.35	.38	.40	.43

TABLE B

Resistance to be connected in series with secondary (charger to battery lead) of Balkite trickle charger as shown in Fig. 5 to give varying rates of charge.

Resistance in Ohms	0	2	4	6	9	15	25	50
Rate of Charge 4-Volt Battery	.52	.43	.35	.30	.25	.19	.13	.07
Rate of Charge 6-Volt Battery	.42	.34	.30	.25	.20	.15	.10	.04

The Construction of a Chemical Rectifier Type Trickle Charger

A CHEMICAL rectifier type of trickle charger consists of the following parts: a transformer, a chemical rectifier, and a suitable switch.

The transformer is preferably made at home if the constructor is able to secure the necessary core. If the constructor does not want to make the transformer, he may use a so-called "toy transformer" such as is used to run toy electric trains, operate Christmas tree lights, and any number of other such things. A transformer should be selected that is made by a reliable manufacturer. It should not consume excessive power at no load.

The transformer shown in Fig. 6 is the 40-watt Lionel transformer with the case removed.

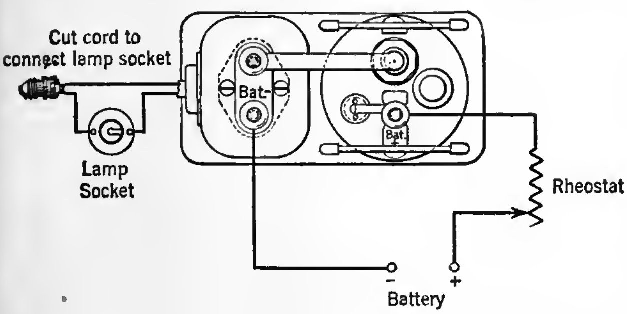
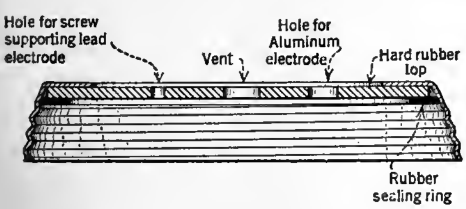


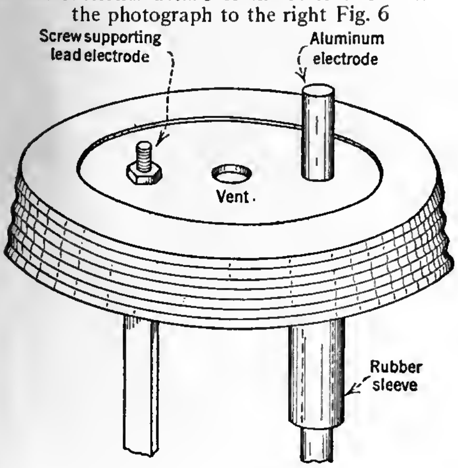
FIG. 5

Either different size lamps in the 110-volt line or a rheostat in the battery line may be employed to vary the charging rate of the Balkite trickle charger shown in Fig. 4



FIGS. 7 AND 8

Constructional details of the rectifier shown in the photograph to the right Fig. 6



CONSTRUCTION OF A TRANSFORMER

FOR the benefit of those readers who have the facilities for making a transformer, the following data is given:

Magnetic circuit
Mean length 9 inches.
Sectional area 60 cycles, 1 square inch, 25 cycles 2 square inches.
Material 10 to 17 mil silicon steel. Shellac each lamination before assembling.

Primary
800 turns No. 26 enameled copper wire, layer wound and layer insulated.

Secondary
No. 20 d. c. c. copper well insulated from primary. Take taps at 109, 131, 153, 175, 196, 218 turns corresponding approximately to 15, 18, 21, 24, 27 and 30 volts a. c. total turns 218.
Intermediate charging rates to be obtained by rheostat.

The "40-watt" rating of a transformer does not, as in the case of some other electrical appliances such as bulbs, flat irons, heaters, etc., mean that it consumes 40 watts of electrical energy, but that 40 watts of electrical energy may safely be taken from it without causing it to overheat. The transformer itself consumes very very little power (if well made) and merely serves to take electrical energy from the lamp socket at one voltage (usually 110 volts) and deliver most of it out again at some other voltage. It is in this case, about 20 volts.

MAKING THE RECTIFIER

THE rectifier is made from a quart size Mason jar. The porcelain lining is removed from the top. A large round opening is then made in the metal top as shown in Fig. 7. The electrodes are fastened to a hard rubber disc cut from a piece of radio panel. A soft rubber gasket such as ordinarily used for sealing Mason jars, is placed on the lower side of the hard rubber disc before fastening in place as shown in Fig. 8.

High and low solution level marks may be indicated on a small strip of paper pasted to the side of the jar. The illustration shows how that can be done roughly.

Two electrodes are employed in the rectifier.

FIG. 6

A home-constructed trickle charger of the lead-aluminum type

RADIO BROADCAST Photograph

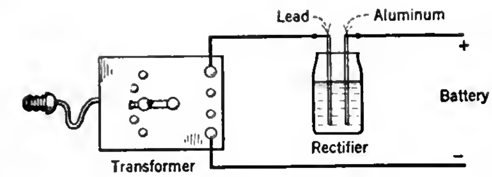


FIG. 9

The trickle charger connections are few and simple. A good quality flexible No. 18 rubber covered wire is well suited to the purpose

One of these electrodes is a rod of pure aluminum. The aluminum electrode is the valve electrode and the success of the rectifier depends largely upon its purity. All grades of aluminum cannot be used. The chemically pure aluminum rods sold by chemical supply houses are generally very satisfactory, although occasionally an unsatisfactory rod will be obtained. Some rods may be very good at one end and quite poor at the other end. Commercial aluminum cannot generally be used for rectifier electrodes. Sheet aluminum is, as a rule, less satisfactory than rod stock.

The diameter of the rod is of no great importance so long as the desired active surface area is obtained. The rectifier shown in Fig. 6 has a $\frac{5}{16}$-inch diameter aluminum rod with an active lenth of 7 inches. If a larger size rod is employed, its length should be such that the same area is exposed as for the $\frac{5}{16}$-inch rod.

An important part of the aluminum electrode is the rubber insulating sleeve. This sleeve is made of heavy walled "live" rubber tubing, which is stretched over the upper end of the rod so as to keep the active area of the electrode constant regardless of the height of the solution. (between the "high" and "low" level marks). Another important function of the sleeve is to prevent arcing at the surface of the solution.

The other electrode is generally made of lead. Carbon rods, if the proper kind are used, are more satisfactory than lead rods. Suitable carbon rods are, however, rather difficult to obtain. Old battery carbons cannot be used. The best material to use, if one can secure it is a high-silicon iron rod. The silicon content must be high enough to prevent oxidation.

The lead may either be pure or contain antimony. Its purpose is merely to make electrical connection to the solution. Pure lead is very soft, and for this reason the harder lead-antimony alloy is to be preferred. Lead containing antimony is used in the manufacture and repair of storage batteries. It can be obtained from any storage battery service station. Ordinary sheet lead may be obtained from any plumber.

The lead electrode may be either round or flat. Its size and shape is of no importance as long as its active area is about equal to or greater than the active area of the aluminum electrode. The two electrodes should be placed as close together as possible without being closer than one half inch at any point. Both electrodes must be rigidly supported by the cover so that there will be no danger of them touching.

Sandpaper or scrape the lead until it is bright and clean. Then assemble the rectifier and use it for several days or until the lead electrode has turned a dark red color. Then remove the lead electrode and hammer it so as to force the dark brown coating into the surface of the lead. This treatment, although not essential, will greatly prolong the active life of the rectifier as it will prevent the lead electrode from slowly disintegrating.

THE SOLUTION FOR THE RECTIFIER

THE solution is made by dissolving as much secondary amonium phosphate, $(NH_3)_2HPO_4$, as will dissolve (about one ounce) at room temperature in sufficient distilled water to fill the rectifier cell to within 2 inches of the top. The solution before using should be shaken every ten or fifteen minutes for about an hour. Tap-water should not be used. After the excess crystals have settled to the bottom, pour off the clear solution. Add to this solution 1 oz. $(NH_3)_2HPO_4$ plus (after an hour) $\frac{1}{8}$ oz. K_3PO_4, tertiary potassium phosphate.

After the solution has been poured into the rectifier cell, add enough of any mineral oil, such as castor oil, to make a layer about $\frac{1}{8}$-inch thick on top of the electrolyte.

The transformer, rectifier, and switch are connected as shown in Fig. 9. They should be mounted on a small base board as shown in Fig.6 rather than in a box, so as to facilitate heat radiation. The charger leads are permanently connected to the battery. When the set is to be used, the 110-volt switch is turned off and the filament switch on the panel of the set turned on. By using a standard double-pole enclosed switch of either the "push" or "toggle" type, using the set is reduced to one operation. If a B supply unit is also employed, then one of the Brach switches referred to in connection with the Balkite trickle charger may be used in order to reduce the "starting and stopping" of a set to one operation.

OPERATION

AS EXPLAINED in connection with the Balkite trickle charger, the charging rate at which to set a trickle charger depends almost entirely upon the number and type of tubes employed in the radio set and the average number of hours per day that the set is used. Due to variations in different home made rectifiers it is not possible to make a table showing what adjustments to make for different charging rates. The only practical way in which to tell at what rate the battery is being charged is with a movable coil type of d. c. ammeter. One having a range of from 0-500 milliamperes is excellent. The charging rate is varied by changing the transformer voltage. The proper transformer voltage will be between 15 and 25 volts a. c., depending upon the rate desired and the characteristics of the rectifier. Rates in excess of $\frac{1}{4}$ ampere are hardly advisable, as with the higher rates it becomes necessary to renew the rectifier solution more frequently.

Distilled water must be added to the rectifier cell every month or so, in order to prevent the level of the solution from falling below the bottom of the rubber insulating sleeve on the aluminum electrode. Two or three times a year it will be necessary to clean the electrodes and renew the solution.

LIST OF PARTS

Aluminum rods, C P, may be obtained from most any large chemical supply house. Also from:

Empire Lab. and Supply Co.,
218 East 37th Street, New York City.

Strahs Aluminum Co.
48 Franklin Street, New York City.

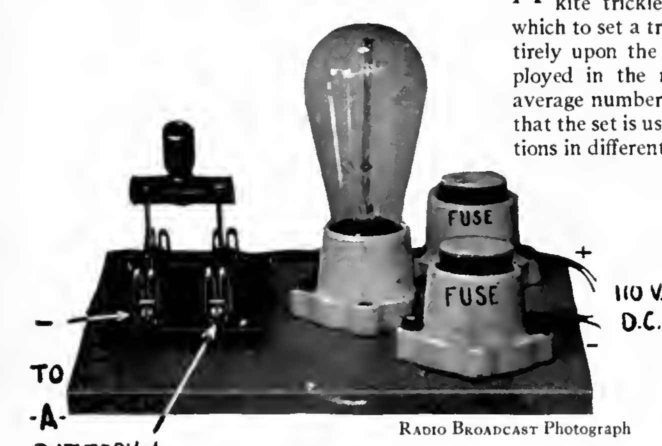
The chemicals may also be obtained from any large chemical supply house, or in many instances, through your local druggist. They must be free from more than a trace of chlorides, iodides, or bromides.

Empire Lab. and Supply,
218 East 37th Street, New York City.

Schaar and Co.,
556 West Jackson Boulevard,
Chicago, Illinois.

A DIRECT CURRENT TRICKLE CHARGER

THE Balkite trickle charger and the home-constructed chemical trickle charger just described must not be used when the house current is d. c. In the business districts of some cities, the power supplied is d. c. In New York City, there are sections in which d. c. is supplied and still other sections where a. c. is supplied. This also applies to some of the residential districts within the city limits. In many other cities, the downtown districts have a d. c. supply, while the residential sections have alternating current. In order to determine whether your home is supplied with a. c. or d. c., and if a. c. the frequency, it is merely necessary to look at the name plate on your electric meter.



RADIO BROADCAST Photograph

FIG. 10

A trickle charger where the current supply is direct current is extremely simple and can be built up in about a half hour. The illustration shows the necessary apparatus

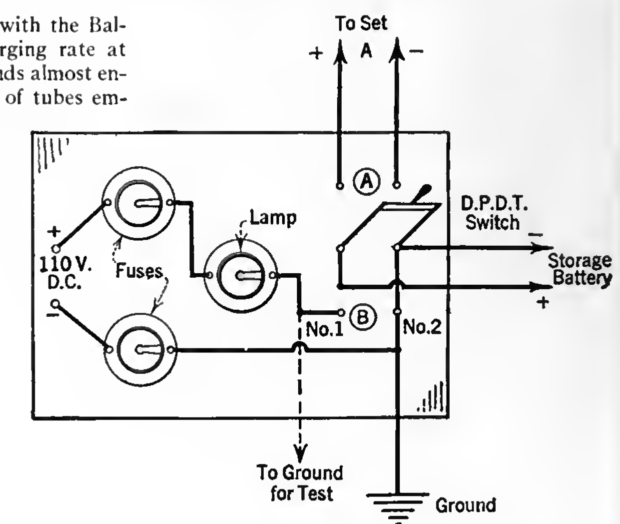
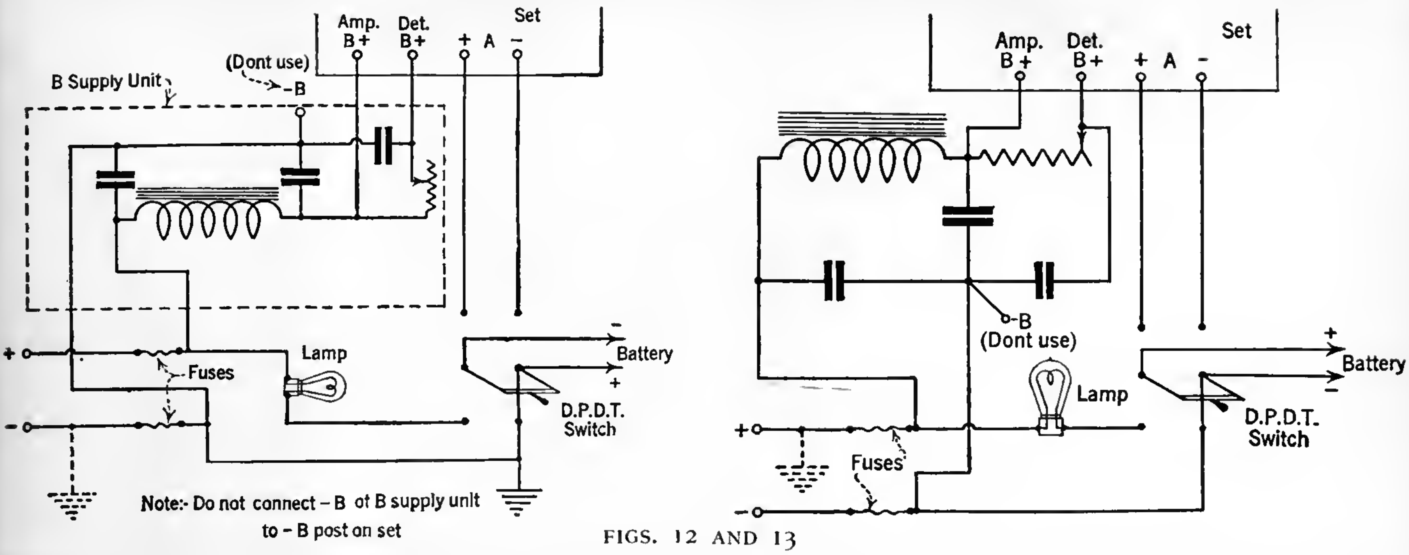


FIG. 11

Circuit diagram for the charger shown in Fig. 10



FIGS. 12 AND 13

In all receivers the minus B lead connects either to the minus or plus A leads. Also in most B supply units the negative side of the output is grounded. Since, when using a trickler charger with such a B supply the negative B will connect to the set through either the minus or plus A leads it is well, to prevent short-circuits, *not to connect the minus terminal* (marked don't use) as shown above, to the receiver

A trickle charger to work with a d. c. supply is a much simpler device than for a. c., as neither rectifier nor transformer are required. All that is necessary is a lamp cord, for connecting to the lamp socket, a lamp to regulate the charging rate, and some fuses.

A convenient way of mounting the essential parts is shown in Fig. 10. The following material is required:

3 Porcelain lamp sockets
Flexible lamp cord and plug
Double-pole double-throw switch
Baseboard

When the apparatus has been mounted and wired up, screw the plug into the lamp socket or outlet in which it is to be used later on in charging the battery. The plug had better be one of the non-separable type, as once the proper connections are determined, reversing the plug would cause considerable trouble.

Insert the necessary fuses (5-ampere, or smaller if you can get them) and any convenient lamp, say 25-watt size in their proper sockets. Then from the post marked No. 1 in Fig. 11, run a wire to the radiator, water pipe or other ground. Note whether or not the lamp lights. If it does not, then reverse the connections from the lamp socket. The lamp should now light. After arranging the lamp cord connections so that the lamp on the charger panel burns when post No. 1 is grounded, determine the polarity of post No. 1.

The simplest way of determining the polarity is by connecting two bare wires to posts No. 1 and No. 2. Dip those wires into a glass of water to which has been added some ordinary table salt. Bubbles will soon start to rise from the negative wire. Mark post No. 1 plus or minus as the case may be.

The regular ground wire must now be removed from the set and connected as shown in Fig. 11. If your set is of the type in which there is no connection between the antenna coupling coil and the filament circuit, then it will be necessary to retain the regular ground connection to the set, but in that case, for the sake of safety, put a .002-mfd or larger condenser in series with this ground wire.

The switch at the lamp socket must at all times be turned on. So must the filament switch on the radio set. To use the set, throw the switch to position A, Fig. 11, and when the set is not in use, to position B, which puts the battery on trickle charge. If the set is not to be used for some time, then the charger and set are both disconnected by leaving the switch in the up position. A much neater and better way is to use an enclosed type switch, in place of the knife switch.

When all connections have been made, throw the switch to the "charge" position. The lamp should burn just a trifle less bright than when in an ordinary lamp socket. It may be difficult.

TABLE C

LAMP WATTAGE	APPROXIMATE CURRENT IN AMPERES
10	.086
15	.13
25	.21
40	.34
50	.43
60	.51
75	.64
100	.86
150	1.3
200	1.7

however, to notice the difference in brilliancy. If you should notice that it burns a trifle brighter, then it is clear that there is a mix-up in polarities. The circuit should be carefully checked at once and the error rectified.

After all is functioning properly, it is necessary to adjust the rate of trickle charge, so that just about as much or a little more current is put back than is taken out of your battery in a day. The charging rate is varied by using different size lamps. It is especially important to note that the battery should be at least three-fourths or

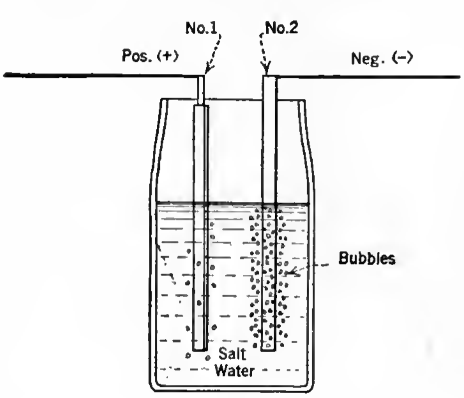


FIG. 14

A glass of water in which some table salt is dissolved, is useful in determining the polarity of a direct current line

more charged (as indicated by a hydrometer) before it can be put in the trickle charge circuit and forgotten about (except, of course, for the occasional addition of distilled water).

Suppose, for example, that we have a five-tube neutrodyne equipped with 201-A tubes each of which takes $\frac{1}{4}$ ampere. The total current drawn is thus 5 x $\frac{1}{4}$ or $1\frac{1}{4}$ amperes. Now, if we use the set on an average of four hours per day, 4 x $1\frac{1}{4}$ or 5 ampere hours is drawn from the battery. The average efficiency of a storage battery is about 75 per cent. We must then return to the battery 5 x $\frac{100}{75}$ or $6\frac{2}{3}$ ampere hours per day. If the set is in use for 4 hours, then we have 20 hours in which to charge the battery. $6\frac{2}{3}$ amperes divided by 20 is $\frac{1}{3}$ amperes, the hourly rate at which the battery must be charged. By refering to Table C, it will be seen that by using a 40-watt lamp, this charging rate is obtained.

By applying this same line of reasoning, the proper size lamp to use for any condition can be readily determined.

As the lamp will burn at but very slightly less than full brilliancy (104 volts instead of 110 across the lamp in case of 110-volt supply), it is quite feasible to put an extension to the lamp socket and use it as a cellar light, night light, reading light or any other such purpose. Remember though, that it only burns when the radio set is *not* in use.

When a d. c. B-supply unit is to be used with the d. c. trickle charger just described, care must be used to secure the proper connections.

In cases where the negative side of the line is grounded, use the connections in Fig. 12. When the positive side of the line is grounded, then a B unit cannot be used with the trickle charger connected as shown in Fig. 11, but the trickle charger must be rewired and connected with the B unit in the manner shown in Fig. 13. It will be noticed in this case that the lamp resistor is in the grounded side of the line. Disregard the negative B terminal of the B supply unit, as connection to it will be made through the trickle charger. Connect the negative detector B post in the usual manner.

To determine which set of connections is applicable to your case, use a lamp for locating the grounded side of the line, and a glass of salt water for determining the polarity, as previously described.

Don't get discouraged if the fuses blow. Just check things over again and you'll have no trouble finding the error.

Testing and Operating the "Aristocrat"

How to Use a C Battery—A B-Substitute with Resistance Amplifiers —Modifications in the Audio Output—Details of Home-Made Coils

By HOWARD E. RHODES

IN THE November issue of RADIO BROADCAST there appeared the first of several articles describing the RADIO BROADCAST "Aristocrat", a five-tube receiver designed to give excellent quality of reception, combined with selectivity and sensitivity. It consisted of a stage of tuned radio frequency, regenerative detector, and a resistance-coupled audio amplifier. It appealed greatly to home constructors because of simplicity of construction and its exceptional tonal fidelity. The circuit is a remarkably efficient one and meets the requirements of the DX fan in a highly satisfactory fashion. Some of the models used a Hanscom single-control tuning unit so that the utmost simplicity of operation was had, while other models used dual control, preferred by many people. The "Aristocrat" has proved extremely popular and there have been many requests for further information concerning batteries, tubes, home-made coils, B substitutes for use with the set, the best method of assembly, etc. In this article we are going to discuss some of these interesting questions. Constructional data appeared in the November, 1925, RADIO BROADCAST and will not be repeated here.

In the first place, there is something to be said about assembly. Whether or not a sub-panel is used depends upon personal preference. The set will, of course, give satisfactory operation with any good electrical assembly. The various methods of construction can readily be seen by reference to the accompanying photographs and those in the November, December, and April issues. The sub-panel layout illustrated in Fig. 4 uses a Bruno Bracket and makes a very neat job. The base board assembly will appeal to others and it is well illustrated in the photographs in the issues mentioned above. The "Aristocrat" is an exceedingly simple circuit to put together —not at all tricky—and any standard procedure can be successfully followed.

MAKING YOUR OWN COILS

THERE are a great many radio home constructors who like to build their own coils and Table 1 presents complete data for the construction of various types of coils which can be used in this circuit. There are also a large number of manufactured coils that can successfully be used in the "Aristocrat" hook-up. Excellent manufactured coils are made by the following companies;

Hammarlund, Eastern Coil Corporation, American Mechanical Labs Inc. (Clarotuner), F. W. Sickles Company, Perfection Radio Mfg. Company (Supercoils), Victoreen Radio Products, and several others.

There have also been some questions concerning batteries to be used with the circuit. Particularly with regard to the C battery, there seems to be some confusion as to just what factors determine its value. The bias voltage should be determined by the strength of the signal that is to be handled. A UV-201A should not have much more than $4\frac{1}{2}$ volts of C battery when used in the output stage with 135 volts on the plate. Increasing the grid voltage beyond negative $4\frac{1}{2}$ volts will result in decreased power in the plate circuit. Actually, the power in the output circuit of a UV-201A is not sufficient properly to operate a loud speaker and it is always best to use a semi-power tube in the last stage. These tubes will be able to handle a stronger signal and this change will also result in better operation of the speaker at a power level more nearly correct. Table 2 gives the correct value of C battery to use on each stage of a resistance-coupled amplifier when 135 volts is used on the plates of all the tubes. Practically, not much difference will be noticed if the first two tubes are operated at a lower C voltage, since the lower voltage need not necessarily result in distortion if the signals being handled are not very great, but will only produce a slight decrease in amplification, not detectable by the ear. The important point that should come out through this discussion is: Don't make your C battery voltage much greater than is necessary

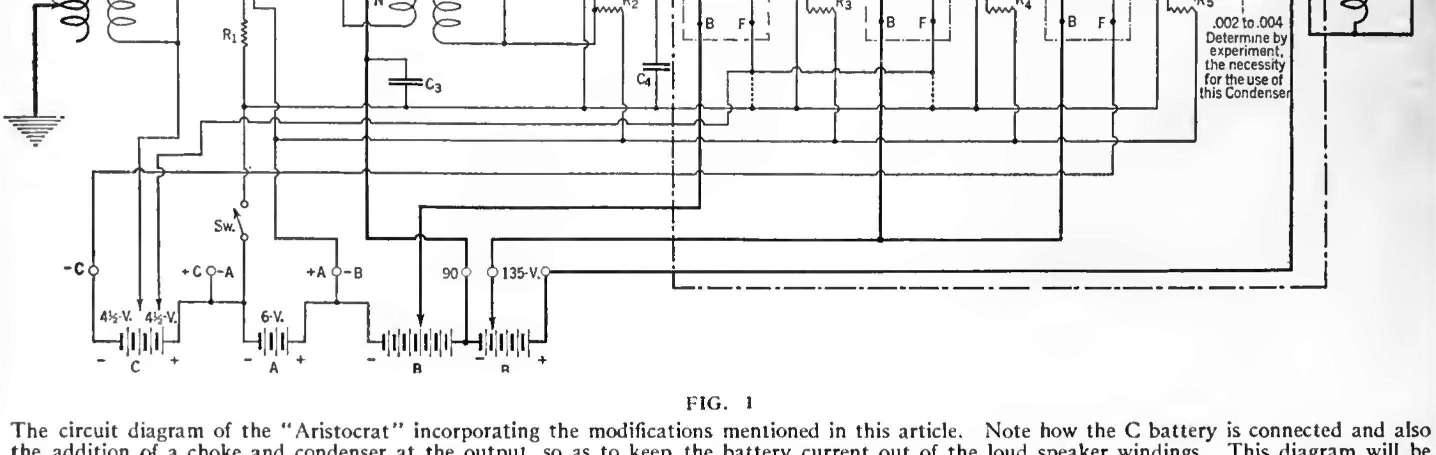


FIG. 1

The circuit diagram of the "Aristocrat" incorporating the modifications mentioned in this article. Note how the C battery is connected and also the addition of a choke and condenser at the output, so as to keep the battery current out of the loud speaker windings. This diagram will be useful for those wishing to use a C battery on all the amplifiers

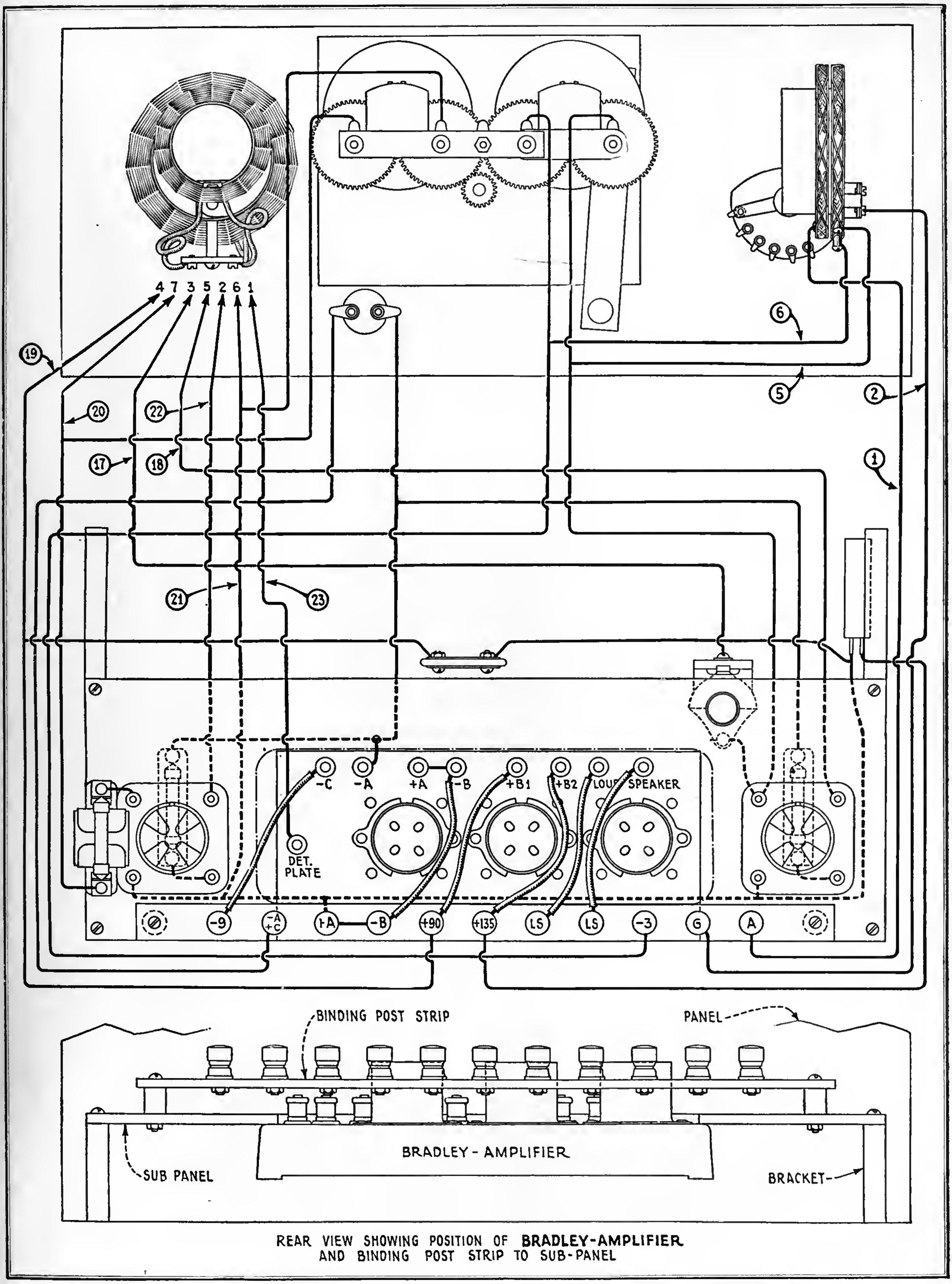


FIG. 2

Here's a simple way in which a manufactured resistance-coupled amplifier unit may be used in an "Aristocrat." Note how the sub-panel has been cut away to handle the signals. Too much voltage may give distortion, decreases volume to a slight degree, and if the excessive potential is impressed on the grid of the output tube it results in operation of the loud speaker at a lower power level than that required for best results.

TABLE I

KIND OF COIL	NO. OF SPOKES	INSIDE DIAMETER	PRIMARY		SECONDARY	
			SIZE WIRE	NO. OF TURNS	SIZE WIRE	NO. OF TURNS
Spiderweb	17	2″	20	14	20	46
	15	1¾″	24	16	24	52
	11	1½″	24	15	24	50
Basketweave	13	2⅝″ between peg centers.	18	18	18	58
	14	4⅛″ between peg centers.	18	20	18	60
	15	2½″ between peg centers.	24	20	24	64
Diamondweave	15	2⅛″	26	18	26	57
	21	2¾″	20	10	20	36
	15	2⅜″	24	14	24	44
Solenoid		2½″	24	20	24	59

THE C BATTERY IN RESISTANCE COUPLING

MANY receivers have been made using a resistance-coupled amplifier purchased as a complete unit. An amplifier of this type is the Allen-Bradley, which is illustrated in the accompanying full page diagram. These units are not wired for the use of a C battery on the first two tubes and if it is desired to use one, it will be necessary to get inside of the unit and take off a tap at the correct point. This can be determined by reference to the circuit diagram shown in Fig. 2. As shown on the drawing, it is necessary to break the connection to the filament end of the grid leaks on the first two tubes and then bring out a lead to a binding post. The dotted lines in Fig. 2 indicate the connections that have been removed.

Many readers have tried to use a B battery substitute for supplying the plate voltages for the various tubes in the resistance-coupled amplifier and have found that when this is done it sometimes produces a loud hum. This hum is caused by the impedance of the B battery eliminator, which feeds back energy into the first tube of the amplifier. If moving the eliminator further away and using twisted leads to be B binding posts on the set does not eliminate the hum, it becomes necessary to use dry batteries for supplying the plate voltage for the amplifier tubes. The eliminator can, of course, be used to supply the various other plate voltages required for the receiver. It will actually be necessary to use ordinary B batteries on only the first two tubes of the resistance-coupled amplifier.

In the interest of good quality, it is also wise to use the method of connection to the loud speaker that is indicated on the circuit diagram, Fig. 1. L is a choke coil having a very high inductance and C is a large fixed condenser with a capacity of about 2–4 mfds. This connection results in the elimination of the battery current from the windings of the speaker so that the only current flowing through them is that current which produces sound. For the choke coil L it is possible to use the secondary of an audio transformer. Excellent units for just this purpose are made by the General Radio, Acme, Thordarson, Amertran, and several other companies.

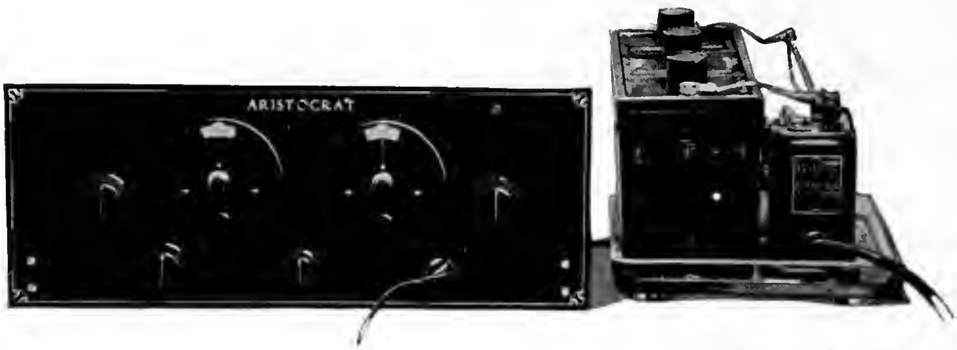
THREE-VOLT TUBES IN THE R. F. STAGE

THERE is another circuit variation in which there is considerable interest, and that is whether or not satisfactory operation can be had using a 199 type tube in the radio frequency stage. The amplification obtainable with this type of tube will, of course, be somewhat less than that of a 201-A but a compensating advantage is that neutralization, using a 199, is an exceedingly simple matter. The change from a 201-A type to a 199 type tube is very simple. It is merely necessary to remove the filament control resistance in the radio frequency stage and substitute a new fixed resistance designed for use when a 199 tube is to be supplied from a 6-volt battery. See "The Use of the Filament Resistance," Radio Broadcast for April, 1926. If the set is well constructed, it will still be necessary to neutralize it but the job is not at all difficult.

Radio Broadcast Photograph

FIG. 5

The "Aristocrat" in a cabinet. Space is provided below the set for all necessary batteries. The cabinet is made by the Detroit Woodcraft Corporation



Radio Broadcast Photograph

FIG. 3

The "Aristocrat" with dual control. Dual control has the advantage that it does not require the accurate matching of coils that is essential if single control is to give satisfaction. It will also enable those who have their own condensers and dials on hand to use them

And now we come to the final point—location of trouble. Unfortunately, every receiver does not operate perfectly when it is first put together and so a few pointers with regard to trouble hunting should prove useful. In making these tests, the receiver should be completely connected, exactly as it would be under ordinary circumstances.

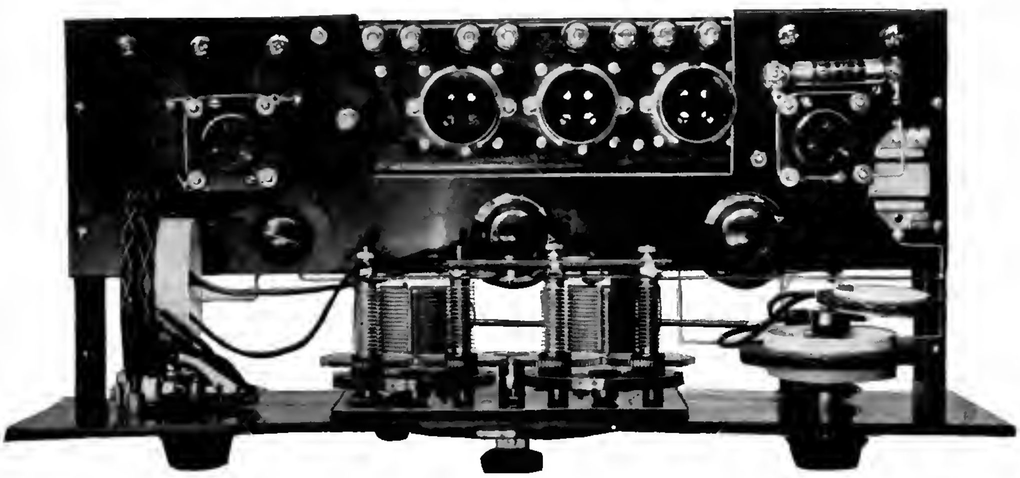
In testing a newly made receiver, the first unit that should be looked over is the audio amplifier. The simplest way in which to test this unit is to listen-in on the output, using a pair of head phones, and then lightly tap the detector tube. A loud microphonic ring should be heard and this noise is a quite certain indication that the audio amplifier is functioning satisfactorily. If the test fails to give any response we may be sure that at some point the amplifier is at fault and it is wise to make whatever additional tests are necessary in order to localize the defect. In a resistance-coupled amplifier, a common cause of failure is defective grid or plate resistances. A systematic electrical test of the various parts of the amplifier should show up the trouble and it can then be repaired.

The next part to be tested is the detector circuit. A good check on this unit can be made by connecting the antenna to point No. 5, Fig. 1, on the secondary coil in the detector circuit. The radio frequency tube can be removed from its socket and under these conditions the set should function as an ordinary three-circuit regenerative set and results should be equal to those obtainable with that type of receiver. If, on the other hand, very poor or no reception is obtained, trouble should be looked for somewhere in the detector circuit. Examine all the coils and be sure connections are tight since this is a common cause of trouble. Various grid leaks should be tried and that one used which gives the smoothest regeneration. Try different tubes, making sure that the socket contacts make good connection with the tube prongs. After this part of the circuit is made to function properly, the antenna can be connected to point No. 3 and then on point No. 4. If good results are had up to this point, any further trouble can be looked for in the radio-frequency amplifier.

To test the radio-frequency amplifier, the antenna can be connected to point No. 2. With the antenna at this point, the signals should be very loud and if this is not the case it indicates either a defective tube or a defective coil. Try a new tube and if results are the same it is likely that the fault will be found in the coil or in the wiring connecting it in the circuit. When best results are obtained at this point, the antenna can be connected to the antenna binding post and the receiver should now function in the proper manner. In order to obtain best operation, various plate voltages and grid voltages (on the radio frequency tube in particular) should be tried. Be sure not to put too much grid voltage on the r. f. tube (see Table 2) because it will tend to make this tube act partly as a rectifier and results will then be very poor. The usual troubles can ordinarily be found after systematic search and, in general, will be quickly and easily located.

TABLE II

Type of Output Tube	C Battery Voltage			B Battery Voltage	
	First High Mu Tube	Second High Mu Tube	Output Tube	High Mu Tubes	Output Tube
201A type	1½	1½	4½	90	135
112 type	1½	3½	9	90	135



Radio Broadcast Photograph

FIG. 4

This receiver was assembled using a Bruno bracket. It should be noted that the sockets extend far enough beneath the sub-base to allow wiring to be done at approximately the level of the socket prongs

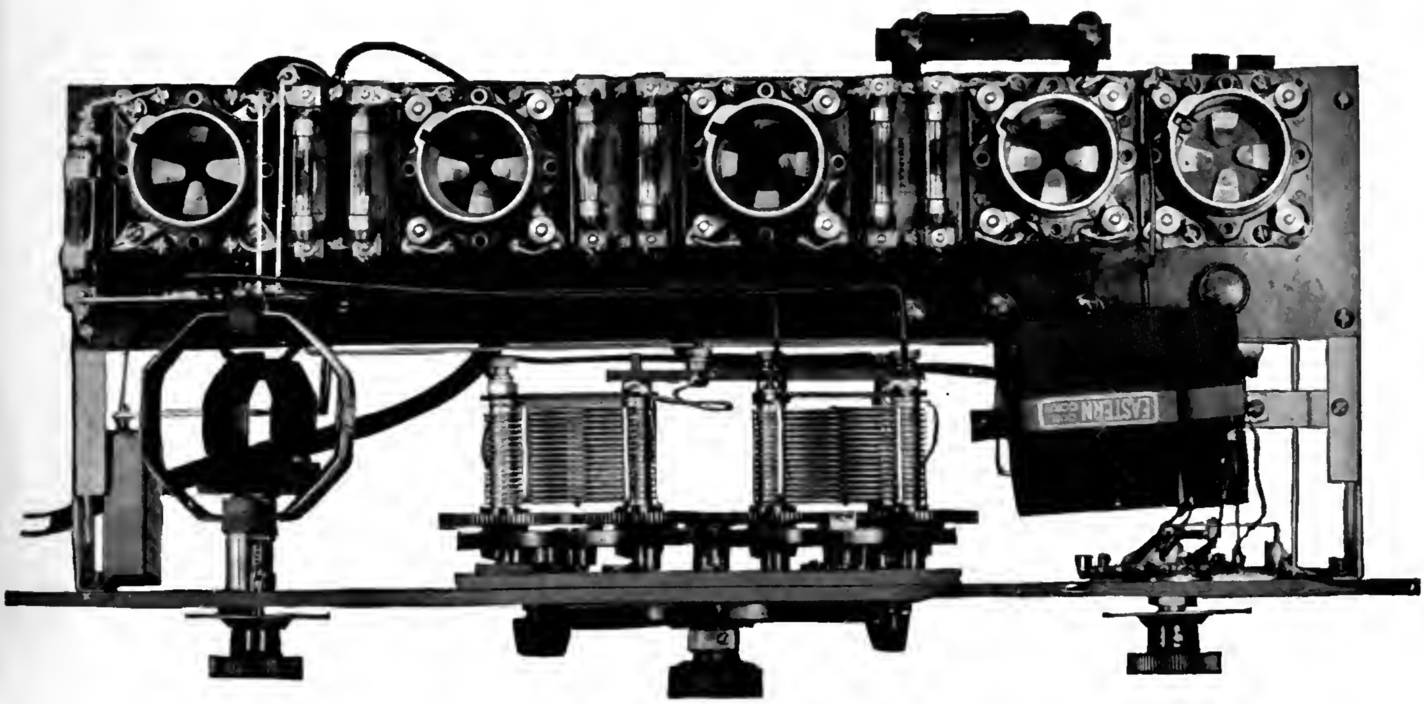


FIG. 5

Another model of the "Aristocrat." Any standard parts may be used and it will be found easy to revise the position of the wires so as to produce a well-designed set irrespective of what parts are used. The actual wiring of an "Aristocrat" is a very simple matter. Some readers might want to duplicate the model shown above so below appears a list of the apparatus used. Left to right on the sub-panel we have the Daven Leakandenser, Benjamin socket, Sangamo .004-mfd. bypass condenser, Daven resisto-coupler with .1 and 1 meg resistors, socket, resisto-coupler with .1-and ½-meg resistors, socket, resisto-coupler with .1-and .25-meg resistors, socket. The .1 mfd. condensers are within the resisto-couplers. The two Eby posts on the upper strip are for the loud speaker. The three posts on the lower side are for the C battery, and the small knob is for the Hammarlund variable neutralizing condenser. Left to right on the main panel are the Benjamin bracket, Dubilier .5-mfd. bypass condenser, Eastern Knockout r. f. coupler with Apex knob, Hanscom single control unit with Marco dial, Yaxley filament switch, Eastern Knockout antenna coupler with Carter antenna switch.

THE GOVERNMENT EXAMINATION
Applicants for Government commercial or amateur operator's licenses must take the examination set by the Department of Commerce. For a first grade amateur license, a speed of 10 words per minute is required. The test is given by a mechanical transmitter which sends for five minutes

Easy Methods of Conquering the Radio Code

Short Cuts to Learning the Code and a Word About the Fascinating Fields Opened Up to the Listener Who Can Translate the Dots and Dashes

By EDGAR H. FELIX

FOR the benefit of those who were asleep at the conclusion of our last lecture," said the Professor, looking directly at me, "I will repeat several of the points which I made."

Naturally, all eyes were focused upon me as the class indulged in a hearty laugh at my expense. The Professor had his revenge and I immediately plotted mine. Then and there I determined to make him a slave to radio, which had been the cause of my undoing. Not only did I achieve my purpose in a few short weeks, but also secured the aid of a capable psychologist in perfecting a simplified method of learning the code, into the bargain.

My first step was to inveigle the Professor into an evening of listening. First, we listened to ships along the coast calling various shore stations all the way from Cape Race to Guantanamo Bay, Cuba. Then we stepped up to the 800-meter mark and heard a number of compass stations giving bearings to ships. I copied the messages as they came through and I could see the Professor trying to make out dots and dashes, of course without success. At a thousand meters we heard radio beacons and continued up the scale through commercial, naval, and military stations until we were away up on the long wavelengths with their chorus of international high power stations in all parts of the world.

But the thing that really clinched the matter was an sos call, which accomplished its usual disruption of ether communication. A yacht had collided with a passenger steamer. I copied messages from all the ships and shore stations concerned, none of which were more than 100 miles away. There was nothing which appeared particularly exciting to me about the accident; both ships were safe and no one was hurt. But the Professor was thrilled!

One hour at the phones had done its deadly work. A week later I had the satisfaction of following the Professor, walking to College one morning, whistling in the dots and dashes of the Continental code, the name of a hand laundry as he passed its sign; then he walked by a barber shop and Tony's name was broadcast in dots and dashes for the first time. It would be only a matter of time, I gloated, before he would fall asleep at his desk in front of the entire class.

Any one who has listened for an hour to the traffic passing through the ether by the dot and dash method is certain to make an attempt to learn the code. Now that it is possible to hear and communicate with amateurs in all parts of the world on short-wave, low power transmitters, the profit and pleasure resulting from a knowledge of the code is still greater than it was at the time of the Professor's downfall; certainly any one will be repaid if he succeeds in mastering the language of dots and dashes.

THE VIVID WORLD OF CODE TRANSMITTING

TO THE trained ear, the dots and dashes are much more than just letters of the alphabet. Every operator has his own style of sending which reveals his personality more faithfully than does his handwriting. Men and women in every walk of life are represented in the amateur ranks. Here may be an Argentinian millionaire holding dot and dash converse with a New Zealand farm hand. A slight turn of the dial may bring you a Hawaiian sending a message of friendship to a London cockney. Another readjustment of the controls may bring you the commercial station sending its mathematically correct dots and dashes by machine. After a few months of listening you can often judge of the character of the man behind the key by the manner in which he sends the code.

A simple and efficient one-tube long-wave receiver can give you, in the course of two minutes, signals from many of the commercial and military high power stations, perhaps in England, France, Italy, Argentina, Hawaii, Japan, or Java. In the last analysis, the broadcasting band, although familiar to the largest number of people, is a relatively small part of the radio world. The code listener never complains about the similarity of the program because

THERE is no system for learning the radio code which will permit that achievement overnight, but there are ways of making the job easier, and Mr. Felix's article gives some valuable suggestions of that sort. So much of interest goes on over the ether channels which the broadcast listener never hears because he is practically deaf to the dots and dashes. The short-wave amateur channels afford the best place to start because the transmissions are slow, and next come the commercial long wave intercontinental circuits. Those who do become proficient in the code should remember that the radio law is very specific in stating that no communication by radio shall be divulged except to the authorized addressee. Licensed operators are required to take oath to this effect. If the DX fiend gets throbs from the voice of an announcer on the other side of the Continent, consider the thrill before him when he can read the key of a station on the other side of the world, or the nervous "fist" of an operator sending an SOS *aboard a ship in distress!*—THE EDITOR.

he has a constant variety of message traffic and may shift the scene from place to place over distances which makes the mere broadcast listener envious.

Some people have great difficulty in learning the code; to others it comes quite easily. Learning the code is greatly facilitated by a natural aptitude for remembering a succession of sounds. There are some people who can whistle a melody which they have heard but once. Others have to hear it a hundred times to repeat the first bar successfully. The chances are that the former can learn the code in a few hours, while the latter may have a tedious struggle unless he uses the correct method in acquiring it.

The mistake most frequently made in attempting to learn the code is that the would be operator tries to "memorize" the Continental Morse alphabet. He may be able to repeat fluently, after some study, the entire alphabet, beginning with "A, Dot Dash," "B, Dash Dot Dot Dot," and so on. But when he begins to listen to radio signals he will not be able to distinguish a single letter. He has simply learned words *about* the code rather than learning the code itself.

A much more successful method is to whistle the sounds of each letter so that a connection is formed between the center of hearing and the letter which you are trying to represent by sound. The other method is equivalent to trying to learn the playing of a musical instrument by talking about it.

LEARNING THE CODE AT HOME

BETTER yet, obtain a buzzer and key and learn to "pound out" the alphabet. The photographs show the most accepted way to hold the key, with the thumb underneath and the first and second fingers on top if it. The finger grip is easy and light, practically no effort being required to press the key. Note how high the wrist is held. The impulse for pressing the key is obtained from the arm muscles and not from the fingers. If you conceive the fingers and hand up to the wrist joint to be a part of the key itself, you are most likely to get the correct motion. If you watch a telegraph operator you will see that his wrist goes up and down with each pressure of the key. His arm actually pushes his *wrist* up and down, while the fingers and hands remain practically motionless, merely transmitting the impulses from the arm to the key itself. If he were to use his fingers instead of his wrist, he would soon have telegrapher's paralysis or a "glass arm," in the lingo of the radio cabin.

Mechanical devices are available which automatically send messages, for instruction purposes. Usually these employ a spring motor rotating a disc which operates a contact switch. On the periphery of this disc, indentations spaced according to letters and words of the Continental Morse code, actuate the contact switch, controlling a high-pitched buzzer. Mechanical senders such as the omnigraph are used widely in schools because the government examinations for commercial licenses use the omnigraph to test the applicants. Experienced operators usually find it difficult to copy from the omnigraph because it lacks the free swing of hand sending. But it is valuable in learning to read the code because the speed may be regulated to fit the student's progress. A mecanical sender is a part of the equipment furnished students of most correspondence schools which teach the radio code by mail. The correspondence school method, aided by the use of a simple long wave receiver is one excellent way to learn the code. In various cities, there are schools which teach the code and practical radio operating as well. These schools are of great value for the individual who is eager for supervised code or theoretical and practical instruction.

The first step, then, is to memorize the *sounds* representing the letters of the alphabet by actually sending them with a key and high pitched buzzer. This process is facilitated by grouping letters and becoming thoroughly familiar with each group one at a time. For the first group, learn the "dot" letters:

e	•
i	••
s	•••
h	••••
5	•••••

When you can send any of these instantly, smoothly and easily, ask someone to read different combinations of three or four of these letters. Send each combination twice until your hand forms each letter automatically and your ear

INTERNATIONAL MORSE CODE AND CONVENTIONAL SIGNALS

1. A dash is equal to three dots.
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to five dots.

A	• —
B	— • • •
C	— • — •
D	— • •
E	•
F	• • — •
G	— — •
H	• • • •
I	• •
J	• — — —
K	— • —
L	• — • •
M	— —
N	— •
O	— — —
P	• — — •
Q	— — • —
R	• — •
S	• • •
T	—
U	• • —
V	• • • —
W	• — —
X	— • • —
Y	— • — —
Z	— — • •
Ä (German)	• — • —
Á or Å (Spanish-Scandinavian)	• — — • —
CH (German-Spanish)	— — — —
É (French)	• • — • •
Ñ (Spanish)	— — • — —
Ö (German)	— — — •
Ü (German)	• • — —
1	• — — — —
2	• • — — —
3	• • • — —
4	• • • • —
5	• • • • •
6	— • • • •
7	— — • • •
8	— — — • •
9	— — — — •
0	— — — —

Period	• • • • • •
Semicolon	— • — • — •
Comma	• — • — • —
Colon	— — — • • •
Interrogation	• • — — • •
Exclamation point	— — • • — —
Apostrophe	• — — — — •
Hyphen	— • • • • —
Bar indicating fraction	— • • — •
Parenthesis	— • — — • —
Inverted commas	• — • • — •
Underline	• • — — • —
Double dash	— • • • —
Distress Call	• • • — — — • • •
Attention call to precede every transmission	— • — • —
General inquiry call	— • — • — — • —
From (de)	— • • •
Invitation to transmit (go ahead)	— • —
Warning—high power	— — • • — —
Question (please repeat after ......)—interrupting long messages	• • — — • •
Wait	• — • • •
Break (Bk.) (double dash)	— • • • —
Understand	• • • — •
Error	• • • • • • • •
Received (O. K.)	• — •
Position report (to precede all position messages)	— • — •
End of each message (cross)	• — • — •
Transmission finished (end of work) (conclusion of correspondence)	• • • — • —

recognizes each letter instantly. If you have no one to read off combinations to you, write down a series of them and then send them, as follows:

sie	hesi	she
5 hies	isee	sees
esih	sesh	his
sees	hehe	sis
	hihi	

Next, learn the dash group, as follows:

t —
m — —
o — — —
o — — — — —

Note that there is no letter represented by four dashes. Each dash is three times as long as a dot. Master this group, then send combinations of it such as tom, moot, motto, O tom, tomo, and so on. Next, combine the dot group with the dash group. Already you can send simple sentences, such as, "I see Tom," "Tom hit his sis," "50 shots hit Tim."

Pursue the same course with each set of combinations, first mastering the letters and numbers in succession, then forming combinations of these letters, and finally combining these with all the groups you have previously learned.

After learning the alphabet so that you can send any letter instantly, and without mental effort, practice sending from a newspaper until you can do it steadily and smoothly. Be sure the correct proportion between dots and dashes is maintained, that is, a dash should be three times as long as a dot. Leave ample spacing between words. Listen to your own sending, and correct any halting quality until you can send smoothly and evenly. No one can send readable code if the spacing is irregular and the individual code characters are given improper time values. Don't try to send fast until you can send every letter perfectly and with full confidence of what it should sound like.

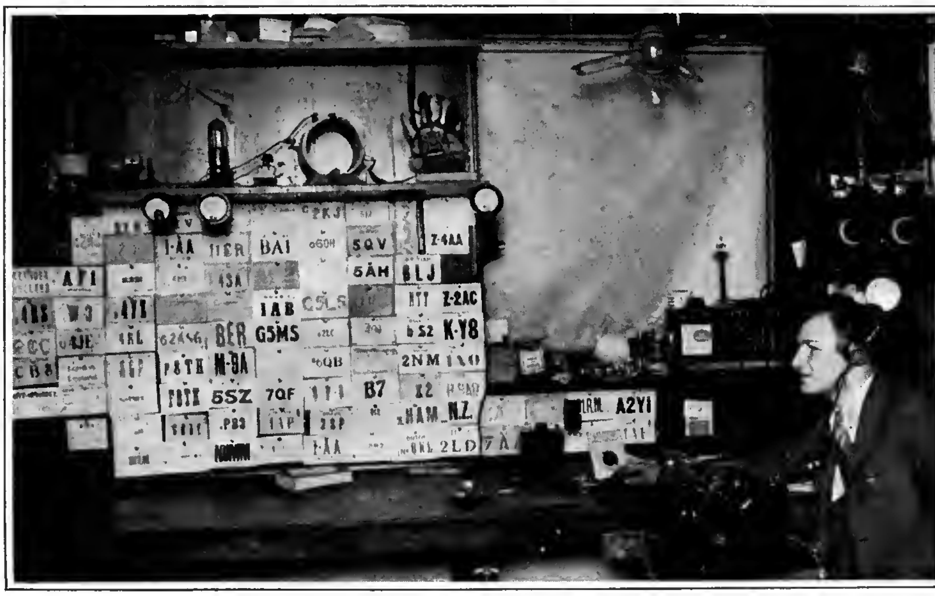
If two people attempt to learn the code together they can greatly expedite the process. While one is learning to send the letters of the alphabet, the

TABLE A

I. Dots		II. Dashes		III. Dot-Dashes	
e	·	t	—	a	· —
i	··	m	— —	w	· — —
s	···	o	— — —	j	· — — —
h	····	o	— — — — —	1	· — — — —
5	·····				

IV. Dash-Dots		V. Dots-Dash		VI. Dashes and Dots	
n	— ·	u	·· —	g	— — ·
d	— ··	v	··· —	z	— — ··
b	— ···	4	···· —	7	— — ···
6	— ····			8	— — — ··
				9	— — — — ·

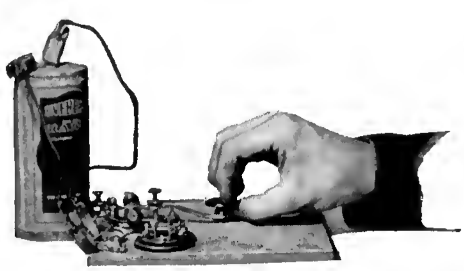
VII. Dot-Dash-Dot Combinations		VIII. Dash-Dot-Dash Combinations		IX. Punctuation	
r	· — ·	k	— · —	Period	·· ·· ··
p	· — — ·	x	— ·· —	Comma	· — · — · —
l	· — ··	c	— · — ·	Fraction	— ·· — ·
f	·· — ·	y	— · — —		
		q	— — · —		



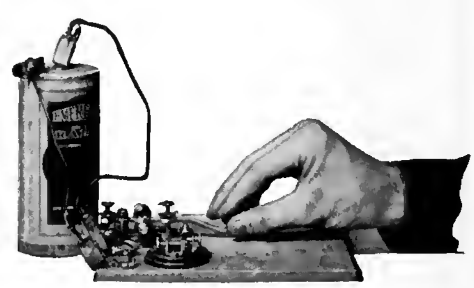
AN AMATEUR OPERATOR AT HOME

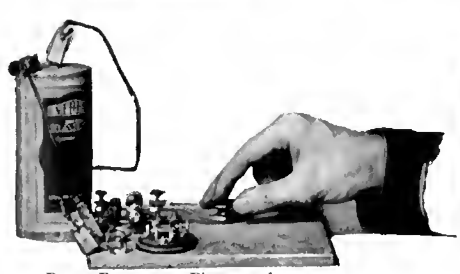
A knowledge of the code, acquired in a few months of intensive study, and apparatus as simple as that shown here, will give the radio experimenter, who has known nothing but broadcasting, some fascinating hours of experience. The transmitting set is on the shelf at the left below which are cards from stations all over the world. The receiver is on the shelf at the right

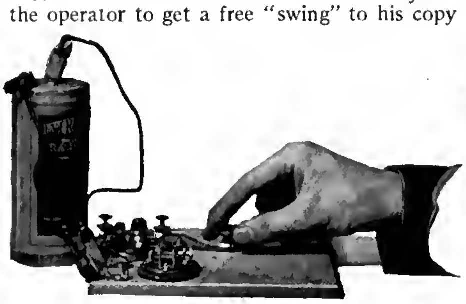
HOW TO HOLD THE KEY

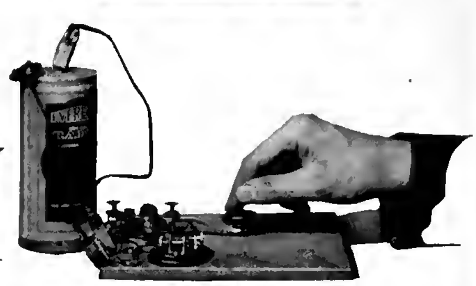


The illustrations at either side, top, shown how *not* to use the key. In the first position, the key is grasped too strongly by the thumb. In the second, the grasp all around the knob makes the muscles of the hand too taut. The three lower photographs show three different ways to hold the key, all satisfactory. The wrist must be above the table, and arched. The motion which operates the key should come from the muscles of the upper arm and the second joints of the fingers be easily flexed. In this way the effort is reduced to the minimum and it is easy for the operator to get a free "swing" to his copy

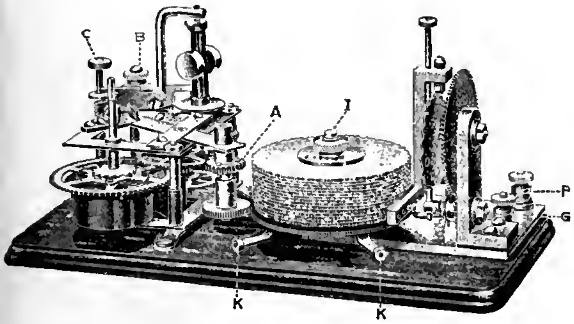






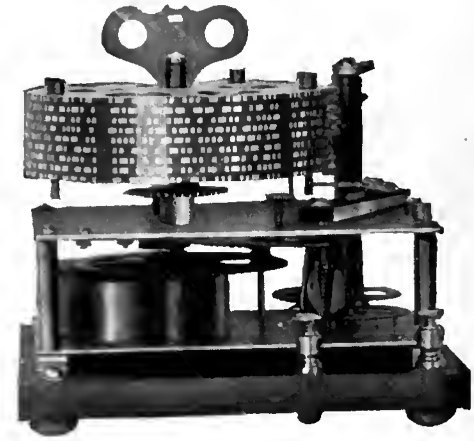


Radio Broadcast Photographs



THE OMNIGRAPH

A well known mechanical device for code practise. The clockwork at the left turns the record table, I, where aluminum records bear the characters of the code. Numberless combinations are possible with this system. The records break the circuit to a buzzer or similar device used to make the signals audible



THE NATROMETER

An automatic code teacher developed and patented by the National Radio Institute Washington. With a device of this sort, a battery and buzzer, plus some ambition it is not hard to learn the code after a reasonable amount of application

other can attempt to receive it. By reversing position at the key and the listening post, it should not take long to read entire sentences. The receiving operator can correct the sender if his spacing is not good.

INTERNATIONAL EAVES-DROPPING

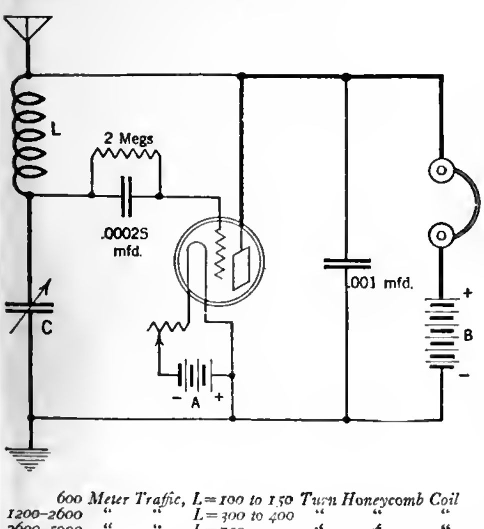
AS SOON as the alphabet has become familiar, the next step is to listen to some of the long-wave transmitting stations. Usually you can find one of these sending very slowly and repeating each word twice.

The construction of a long-wave receiving set, useful in securing code practice at moderate speeds, is very simple. Usually the experimenter has, in his stock of discarded instruments, practically all the essentials required to make the outfit shown in the drawing. Through the use of interchangeable honeycomb coils, any wavelength range desired may be covered. The table to the left shows the correct honeycomb inductance required for covering the wavebands in common use.

Station	Call letters	Frequency	Wave length	When sent
		Kilocycles	*Meters*	
Annapolis, Md.	NSS	17.5	17,130	Daily at 11.55 a. m. to noon and 9.55 to 10 p. m., eastern standard tima.
Arlington, Va.	NAA	113	2,653	Do.
Astoria (North Head), Wash.	NPE	110	2,726	Daily at 11.55 a. m to noon, Pacific standard time.
Balboa (Darien), Panama	NBA	45	6,663	Daily at 3.55 to 4 a. m. and 11.55 a. m. to noon, central standard time.
Cavite, P I.	NPO	57 111	5,260 2,701	Daily at 10.55 to 11 a. m. and 9.55 to 10 p. m. 120th meridian east tima (Philippine standard time).
Colon, Panama	NAX	165	1,817	Daily at 3.55 to 4 a. m. and 11.55 a. m. to noon, central standard time.
Eureka, Calif.	NPW	95	3,156	Daily at 11.55 a. m. to noon, Pacific standard tima.
Great Lakes, Ill.	NAJ	64.0 151	4,685 1,986	Daily, except Sundays and holidays, at 11.55 a. m. to noon, eastern standard time.
Key West, Fla.	NAR	205	1,463	Daily at 11.55 a. m. to noon, eastern standard time.
Pearl Harbor (Wailupe), T. H.	NPM	26.1 133	11,490 2,254	Daily at 11.55 to noon, 180th meridian tima.
San Diego (Chollas Heights), Calif.	NPL	30.6 195	9,798 1,538	Daily, except Sundays and holidays, at 11.55 a. m. to noon, Pacific standard time.
San Francisco (Mare Island), Calif.	NPH	62 225	4,836 1,333	Daily at 11.55 a. m. to noon and 9.55 to 10 p. m., Pacific standard time.

SCHEDULE OF TRANSMISSIONS OF LONG-WAVE TIME SIGNALS

By setting up a long wave receiver, the amateur listener can hear the time signals and weather reports and forecasts. Frequently they are sent slowly, which affords good practise to the learner



600 Meter Traffic, L=100 to 150 Turn Honeycomb Coil
1200–2600 " " L=300 to 400 " " "
2600–5000 " " L=750 " " "
5000–15,000 " " L=1500 " " "

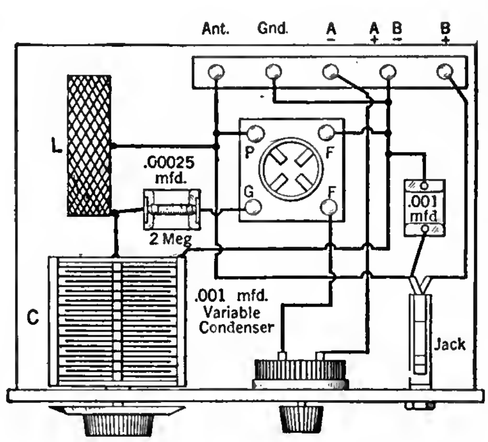
A SIMPLE LONG-WAVE RECEIVER

By using plug-in honeycomb coils, a one-tube outfit such as this shown, will bring in long-wave stations from great distances. On some circuits, traffic is sent slowly and repeated several times which makes grand practise for the beginner

The secret of learning to copy long-wave stations or code sending from any source is to continue copying no matter what you have missed or skipped. Usually you can supply from the context any letters or words which have been skipped.

It is a characteristic of a skillful operator that he writes his message down several seconds after the letter has been sent, keeping two or three words of the text in his mind all the time. In the parlance of operators they call this "copying two or three words behind." The result is a neat looking blank with any missed words or letters supplied by the context of the message.

It is not a tremendous step forward once the code is acquired, to the time when you become an operator of your own transmitting station. Thousands of broadcast listeners are being won over to the hobby of amateur transmission. The principal factor that has deterred most people is that they believe that an elaborate and expensive equipment is needed. But with only a simple receiving tube and a bank of heavy duty B batteries, messages have been sent halfway round the world. The RADIO BROADCAST-Eveready short wave experiments, conducted for the purpose of developing short-wave low power transmission, have done much to stimulate interest in this new and increasingly popular field.



THE LAYOUT FOR THE LONG-WAVE RECEIVER

It should take perhaps an hour to do the assembly work on such a receiver. The novice will be surprised to note how many distant long-wave, high power stations such a set will bring in. Besides learning the code by copying their signals, he will hear a great deal of interesting, sometimes almost romantic, traffic

Drawings by Franklyn F. Stratford

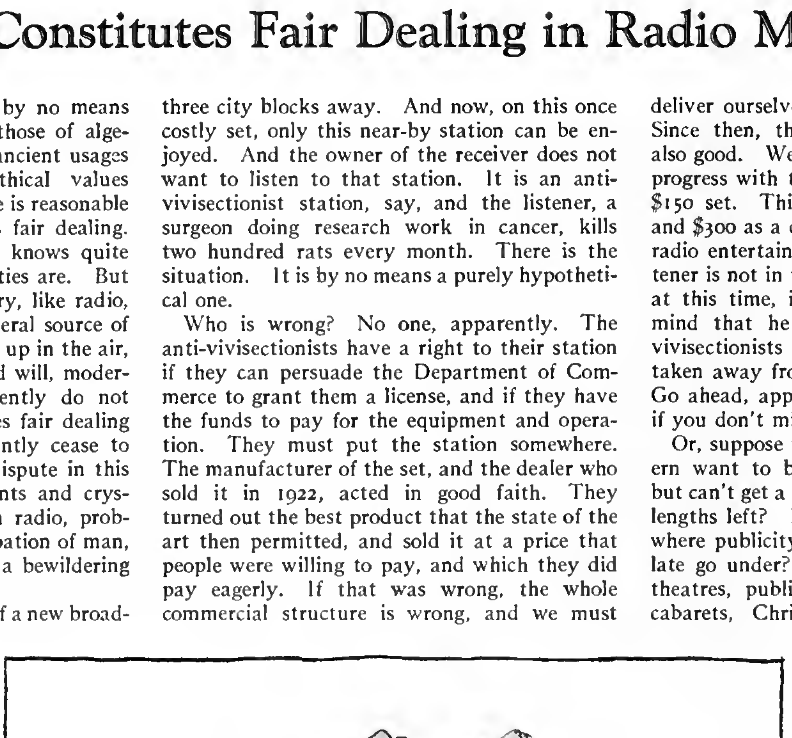
What Constitutes Fair Dealing in Radio Matters?

THE problems of ethics are by no means as definite and soluble as those of algebra, even in fields where ancient usages have standardized the ethical values involved. But in these cases there is reasonable unanimity as to what constitutes fair dealing. In banking, for example, a man knows quite accurately what his rights and duties are. But when it comes to a young industry, like radio, which is at once an art and a general source of perturbation, ethical values are all up in the air, so to speak. Men of normal good will, moderate, well-intentioned men, frequently do not agree at all as to what constitutes fair dealing in radio. Moreover, they frequently cease to be men of good will when they dispute in this field. And not only are precedents and crystallized sentiment lacking, but in radio, probably more than in any other occupation of man, activities overlap and interact to a bewildering extent.

Take, for example, the erection of a new broadcasting station. It is not feasible to locate it in the desert, and inevitably some radio listeners will be near it. Some of these people may have receiving sets which were adequate for their purposes before the new station was planted in their midst. Four years ago a friend of mine wanted a single-circuit regenerative set with two-stage audio amplifier, during the great radio boom. The set cost $150, but actually, none was to be had on the retail market. I did him a great favor by going to the president of one of the large distributing firms and enabling the fellow who had to have a radio set to get rid of his $150. At a moderate distance from broadcasting stations, and close to none, it is still a usable receiver. If he is not too critical of quality, a man might be satisfied with it. He might not be ready to write off the cost of his equipment after the four years he has used it. Why should he, since it is still giving him the grade of service he requires? But someone comes along and plants a broadcasting station three city blocks away. And now, on this once costly set, only this near-by station can be enjoyed. And the owner of the receiver does not want to listen to that station. It is an anti-vivisectionist station, say, and the listener, a surgeon doing research work in cancer, kills two hundred rats every month. There is the situation. It is by no means a purely hypothetical one.

Who is wrong? No one, apparently. The anti-vivisectionists have a right to their station if they can persuade the Department of Commerce to grant them a license, and if they have the funds to pay for the equipment and operation. They must put the station somewhere. The manufacturer of the set, and the dealer who sold it in 1922, acted in good faith. They turned out the best product that the state of the art then permitted, and sold it at a price that people were willing to pay, and which they did pay eagerly. If that was wrong, the whole commercial structure is wrong, and we must deliver ourselves into the hands of M. Trotsky. Since then, the art has progressed, which is also good. Well, you say that the listener must progress with the art, and buy himself another $150 set. This one may last for eight years, and $300 as a capital outlay for twelve years of radio entertainment is not much. But the listener is not in the mood for progress which, just at this time, is to cost him money. Bear in mind that he was satisfied before the anti-vivisectionists came. His satisfaction has been taken away from him. Why should he suffer? Go ahead, apply your ethics. I will side-step, if you don't mind.

Or, suppose that the anti-vivisectionist brethern want to broadcast, and have the money, but can't get a license because there are no wavelengths left? Isn't that a hardship, in a world where publicity is everything and the inarticulate go under? Already flour mills, vaudeville theatres, public service corporations, colleges, cabarets, Christian Scientists, Zionists, and the Y. M. C. A. have stations on the air, and why should not the anti-vivisectionists, who consider their cause vastly important, be given a wavelength? They would have got one, if they had come a little earlier. Let them divide time with an existing station, it is proposed. But the existing stations are filling their time, and want to hold on to it. Half time on the air is worth much less than full time. If a man or a firm has invested $100,000 in a broadcasting station, taking away some of its time may cut the value of the investment 50 per cent. or more. That is confiscation, and not ethics. But should a vaudeville house be allowed to broadcast its frivolities every day, when its primary motive is profit, while the fervent moral crusaders of the anti-vivisection cause remain gagged, just because the vaudeville crew got there first? That must also be painful to the professors of ethics. For it may not be anti-vivisection which is left out in the cold, it may be religion or education or the League of Nations or what



IT IS NOT EASY FOR JUSTICE TO WEIGH RADIO MATTERS worthy or unworthy cause you will. Let the followers of the cause hire time somewhere, you say. But that does not give one as free a hand as when one owns a station. The cause may not be popular to-day, and how shall it become popular if it cannot get a hearing, even with the merit which its proponents assert it possesses. Well, the listeners should decide. A referendum must then be held of all the listeners within range of the existing and proposed stations. Who shall pay for this plebiscite? And will not the existing stations have an unfair advantage? They will certainly plead their cause on the air. They have invested their $100,000 apiece for the privilege of doing so. The problem, you see, becomes complicated. What with conflicting interests, many of them irreconcilable, and the shortage of wavelengths, we have wandered into an ethical morass.

Some musicians are hired to play for a hotel, to assist the salivation and digestion of the guests in the dining room. They are paid a certain sum for their services. The hotel management arranges with a broadcasting station to radiate this dinner concert for the benefit of all and sundry. The musicians claim extra payment for their work, which now performs two functions instead of one. The broadcasters and hotel management deny the claim, maintaining that the musicians play exactly as before and are not entitled to additional compensation. A nice question in equity is here presented.

The copyright question fairly bristles with such problems. If you consider broadcasting as merely an extension of range of sounds already audible to persons assembled at the place of performance, then a license from the copyright owner to play his composition in that place may be construed as implying the right to broadcast. It is equivalent to employing amplifiers and loud speakers in order that the music may be heard clearly by people in remote parts of the hall. But if broadcasting is a separate and distinct operation, then the broadcaster must obtain a license covering his functions. Here the problem is legal rather than ethical, for ethically it will probably be conceded that broadcasting is a separate operation and should be dealt with independently. But if the broadcasting interests are to pay for the copyright privilege, how much should be exacted? And why should the broadcaster pay it all, since the listener enjoys the music?

Some radio manufacturers broadcast. Others do not, but sell apparatus on the broadcasting of the first class. The manufacturers who broadcast are in effect subsidizing their competitors. There is nothing very ethical about the distribution of handicaps in this race, but what are you going to do about it?

There are also many practices in broadcasting which are clearly unethical, but hardly important enough to give rise to lawsuits or assault and battery. A small station is struggling to maintain itself by toll broadcasting. It assigns periods which remain uncovered to volunteer artists. When the station lands another contract it promptly throws off the program any amateurs who are in the way, perhaps offering them another date, perhaps neglecting even this act of decency. In this case the station has clearly violated the principles of fair dealing. But amateur artists do not always live up to their obligations either. They promise to be at the studio at a given time, and fail to appear. This is a double lapse, offending both the station and the audience. Yet it is very common.

Personally, I have no cure for these evils, such as they are. We must wait for the gradual accumulation of ethical standards. Then everything will be sweet, and all the oscillating receivers will disappear. In the meantime, some preacher hunting for a new subject for his Sunday sermon might take an excursion into radio.

Clubless Radio

THE following is a list of professional groups maintaining club quarters in New York City:

Adventurers
Advertising Men
Aeronauts and Aviators
American Dramatists
Army and Navy Officers
Artists
Authors
Bakers
Bankers
Bellevue Nurses
Business Men
Chemists
Clergymen
Colored Vaudeville Comedians
Dining Room Workers
Drug and Chemical Men
East Harlem Workingmen
Engineers
Explorers
Fabric Men
Film Players
Garment Men
Hardware Men
Jewish Writers
Journalists
Lawyers
Machinery Men
Merchant Marine Officers
Merchants
Modern Drummers
Musicians
National Vaudeville Artists
Newspaper Men
N. Y. Hospital Graduate Nurses
N. Y. Newspaper Women
Paper Hangers
Physicians and Surgeons
Professional Chauffeurs
Pullman Porters
Railroad Men
Soldiers and Sailors
Speakers
Swedish Chauffeurs
Telephone Men
Thespians
Wool Men

These are all genuine. I have omitted all groups, such as Fakirs, Friars, Lambs, Jockeys Lions, American Jersey Cattle, and Warriors, where I had reason to believe the members were going under an assumed name.

And where are the radio men? They have no club, strange to relate. There is, of course, the Radio Club of America, which has the name and the membership, but it is a learned society, a sort of younger brother to the Institute of Radio Engineers. Neither of these organizations maintains quarters where one can go to talk business, recline on plush chairs, get away from one's wife, or take a drink, while remaining in the atmosphere of one's profession.

There are already so many near-bankrupt clubs in the metropolis that there is probably no sense in starting another, and yet it is probable that by and by a radio club will appear. The founders will have their bewhiskered images done in oils and hung on the walls for all eternity. Their descendents will say. "There are the old fellows who steered the ship when the trans-Atlantics flivvered in 1926." I do not know that I aspire to this immortality, if it is going to cost me much money, but I have been asked to send up a trial balloon, to ascertain whether there is any interest in such a project. I will be glad to enter into correspondence on the subject.

S O S Publicity

IN PROPOSING the establishment of a central observation station to supervise the frequency adjustment and 600-meter watch of a group of New York broadcasters, the engineer of one plant suggests that a different station be designated each week to give the public information about the sos.

Not a bad idea, but there is a legal stumbling block in its path. No operator's license is valid until the applicant has subscribed to the following oath:

> I, ————, do solemnly swear that I will faithfully preserve the secrecy of all messages coming to my knowledge through my employment under this license; that this obligation is taken freely, without mental reservation or purpose of evasion; and that I will well and faithfully discharge the duties of the office: So help me God.

There is no exemption in this for sos material or anything else. Thus, theoretically, the operator of a broadcasting station may not divulge what he hears on the air during an sos shutdown, although the material is of public interest and there is no good reason why it should not be broadcast when the telephone sta-

THE POOR RADIO MEN IN NEW YORK HAVE NO CLUB AT ALL tions get back on the air. Actually, many of the stations ignore this prohibition. The newspapers, also, secure the desired information, no doubt through wireless operators in some instances. This situation is one which should be brought before the legislative committees now pondering over radio regulation. My suggestion is that the oath be modified to exempt SOS calls and traffic directly pertaining thereto.

Technical Operation of Broadcasting Stations

5. *Equalization*

IN GENERAL it may be said that the low notes in speech and music impart roundness and volume, while the high notes give brilliancy and intelligibility. The high notes, which electrically are in the form of alternating currents of from 3000 to 10,000 cycles per second, are readily lost through the bypassing effect of shunt capacities. See Fig. 1. Here we have an alternating current generator *G* which is assumed to produce currents of various frequencies in the acoustic range, say from 100 cycles per second to 10,000, and to have an internal impedance of 500 ohms, independent of frequency. The output of *G* goes to a line of standard cable, assumed to have a capacity of 0.054 mfd. per loop mile, and to be ten loop miles long. We have no time here to work out the problem in detail, so we shall represent the cable by a lumped capacity of 0.5 mfd., C. The line terminates in a fixed absorbing circuit of 500 ohms impedance. This circuit represents, in a rough way, the combination of a field amplifier, a line, and the input to the audio frequency amplifiers of a broadcasting station.

The reactance of the capacity C of the ten miles of cable is given by the usual formula for the reactance of a condenser

$$X_c = \frac{1}{C\omega} \qquad (1)$$

A USE FOR JAZZ: IT PEPS UP FATIGUED BROADCAST ENGINEERS

where Xc is the reactance of the condenser in ohms
where C is the capacity in farads
where ω is the angular velocity of the alternating current, equal to $2\pi n$, n being the frequency in cycles per second.

For a low note, $n = 100$ cycles per second, we find that the capacitive reactance of the line is about 3200 ohms. In other words, the line will pass low notes on to the terminating transformer with little loss. But it is clear from (1) above that the reactance varies inversely as the frequency of the applied e.m.f., so that at 1000 cycles the reactance of the line considered as a pure condenser is only 320 ohms, while at 5000 cycles, a frequency which it is very necessary to transmit for good broadcast quality, the capacitive bypass is only of the order of 64 ohms. Under these conditions the 500-ohm absorbing circuit is practically short-circuited for the higher notes, from 4000 cycles up, while receiving the low tones strongly. A pair of high impedance telephones at the absorbing end of the circuit will accordingly give a very "drummy," muffled response. Before this stuff can be broadcast, something must be done to "equalize" or "correct" it.

There are various ways of accomplishing this "equalization" of the different frequencies, some very intricate and effective, others relatively simple and good enough for the ends in view.

In the first place it is clear that the capacitive bypassing characteristics of a line are not as serious if the output impedance of the field amplifier at the pick-up end is kept low, inasmuch as the loss of high frequencies depend inversely on the ratio of the output impedance to the capacitive reactance in shunt. That is, when the terminal impedances are low, the line capacity has that much less influence in the determination of the over-all transmission characteristic of the system, since one has to get down lower effectively to shunt a low impedance than a high one. Hence, if instead of working with end impedances of the order of 500 ohms, as is common in telephone practice, we wind the output transformer of the amplifier feeding the line to, say, 50 ohms, the lowering of tone caused by a given line will be much less pronounced. On the other hand, energy is lost by this measure. However, practically all forms of equalization in use by broadcasters lose energy, which must be regained by extra amplification, so we might as well be resigned to that.

The same thing may be done at the receiving end of the cable. The formula for the reactance of a pure inductance is

$$X = L\omega \qquad (2)$$

We see, therefore, that the tendency of an inductance, employed, as a shunt, is to cut down the low frequencies, as a capacitive shunt cuts down the high. Some lines may therefore be

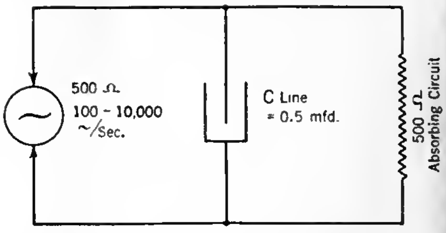


FIG. 1

Shunt capacities in wire lines for broadcasting can bypass the necessary high frequencies

roughly equalized by connecting a small inductance, such as a 60-ohm telephone receiver, across the receiving end, or the field amplifier output, or both. In the latter two cases the ability of the field equipment to ride over line noise is of course reduced. However, in some cases it might be advantageous to provide the field crew with low impedance phones to take advantage of this influence on the transmission characteristic. This effect is also noticed when one listens across a line with a low impedance telephone.

Another simple scheme is to provide an amplifier which is deficient in magnifying the low frequencies, such as a choke coil amplifier in which the coupling inductances are below the values normally used for "flat" transmission. The usual practice, when one wishes to retain the low notes, is to provide a choke whose impedance, at the lowest frequency which one wishes to retain, will be of the order of three times the tube impedance. If the tubes run around 10,000 ohms, for example, inductances with an impedance of 30,000 ohms at 100 cycles will be required. From (2) above, this corresponds to about 47 henrys. Usually values of the order of 100 henrys are preferred. To balance lines, an amplifier might be built with chokes having sliding iron cores, like those of induction coils built to give a shock of adjustable severity, to give a range from, say, 10 to 50 henrys. At 10 henrys, for example, 500 cycles and up would receive practically full amplification with 10,000-ohm tubes, but below 500 cycles the amplification would tail off. Such an amplifier, in combination with a "flat" amplifier with gain which can be regulated, would constitute an adjustable equalizer. The "flat" amplifier would be required to compensate for the varying efficiency of the equalizing amplifier as the inductance values were changed. The two instruments may be combined in one, by the use of a stage or two of "flat" amplification, either transformer, inductance, or resistance coupled, and a stage of low-inductance coupling to get rid of the excess of low frequencies.

In our next issue more elaborate methods of equalization will be taken up.

Embarrassment of Riches

THE broadcaster is often in the unfortunate situation of getting too much of a good thing. Take the case of one engineer. He started listening at 6:00 P. M. one Sunday to a concert by the small but excellent symphony orchestra of George Barrère, broadcast by WEAF. It was an excellent job, and the engineer enjoyed it. Then came the Waldorf Astoria Concert Orchestra, led by Joseph Knecht, one of the field pick-ups of WJZ. He listened to that also, and liked it, particularly because part of the Rimsky-Korsakoff Scheherazade suite, one of his favorites, happened to be included. This ended at 8:00, and was followed by an hour of chamber music by the

Philharmonic Chamber Music Society, led by ErnestSchelling, the same station broadcasting. This was also admirable, but at about 8:45 the listener began to feel satiated. He had been listening unintermittently for two and three-quarter hours, and his appetite was beginning to give out, although he testifies that he loves music and considers it the most fundamental and naturally appealing of all the arts. Furthermore, he was trying to compare the Barrère hour with the Schelling hour, and as nearly as he could judge they were of equal merit technically (from the station transmission point of view) and musically, but he now felt that he should have skipped Knecht in order to start on Schelling with fresh ears, so to speak.

From 9:00 to 10:00 it was his duty to listen to Bernard Levitow's Hotel Commodore Ensemble, and by this time it really was a duty. The pleasure had largely gone out of it, although normally an hour of Levitow's broadcasting would be decidedly a treat to this observer. At 10:00 P. M. Mr. Godfrey Ludlow went on at WJZ for his regular Sunday night half-hour. Although our engineer is a friend and admirer of Mr. Ludlow's, and had promised to report to him on reception, he now quit and hunted around for some jazz. He felt like a low-brow and a scoundrel and all that, but he just couldn't listen to any more good music, and Mr. Ludlow, being an artist, could be depended upon to provide nothing else. Then why didn't the observer quit altogether? For this reason: after he had listened to some pretty ragged and sassy jazz for fifteen minutes, he was able to go back to Ludlow, restored, and to listen to his last twenty minutes with pleasure. If he had merely taken a lay-off for those fifteen minutes, the degree of recuperation would have been less. Thus a use has been found for jazz, aside from its function in dancing. It peps up fatigued broadcast engineers. Stravinsky serves the same purpose, but he is too rare to be of practical use. I can say myself that there are times when I would pay $6.60 to hear that fireworks piece of his, amid the appalling amounts of homophony which we technical broadcasters are paid to radiate and listen to.

Have you ever watched the people behind the counters in candy and ice cream stores? They never touch a sundae or a piece of chocolate candy. Such things are enjoyed most by the infrequent consumer. Similarly radio. What ails us professionals is not a paucity of good music, but an excess of the same. For our sake, some station should take to broadcasting dog-fights.

Memoirs of a Radio Engineer: XI

CAN you imagine an experimenter writing an article on single wire antennas for receiving, getting a prize for it from a radio magazine, having the article published, and then engaging in a lengthy controversy over the question of whether such antennas were to be preferred to the multi-wire type with spreaders? That is hardly a probable situation nowadays, when single-wire antennas outnumber all others in this country, probably in the ratio of one hundred to one, as a result of their adoption by the broadcast listeners. But in 1914 the inverse ratio held, almost all antennas, amateur and commercial, being of the four-wire flat top type, both for receiving and transmitting. Hence when I printed an article, in the January issue of the *Wireless Age* of that year, advocating the use of long single-wire antennas, and giving the results of experiments with that type, my conclusions were immediately challenged.

The multi-wire flat top antenna had come into practically universal use on ships, it being the most convenient type for combination receiving and transmitting in the space afforded by the average vessel. And, in fact, it has retained its position in the majority of marine cases, although the cage type has displaced it many instances. Early amateur rad o was largely copied from marine practice, hence the early part of the second decade of the century was one in which four-wire flat tops held the lead unchallenged, even where the only object was reception of commercial signals, by amateurs. In fact, most amateurs hardly knew that a single wire would receive. If they got a present of one hundred feet of wire for Christmas or a birthday, they proceeded up to the roof and, as a matter of course, erected a 25-foot four-wire antenna. If Providence yielded two hundred feet of the necessary material, then a fifty-foot antenna was put up. But, in the case of those amateurs who wanted to hear the ship-to-shore traffic on 600 meters and other traffic, such as Cape Cod (WCC) and Sayville (WSL) up to about 3000 meters, these antennas were too short for maximum signal strength, however suitable they may have been for 200-meter transmission. This was a fact which some of my friends and I discovered before long, and we took advantage of it by erecting long single-wire antennas between conveniently located apartment houses. Most of us lived in two- or three-story frame houses, and by swinging single wires between two six-story brick apartments, from two hundred to four hundred feet apart, we gained the advantages of both height and length. Of course it was a vital matter for us to get as much energy out of the air as possible, inasmuch as we were limited to crystal reception, and whatever the antenna didn't pick up strongly enough to be audible in the phones after rectification, we had to do without. And the single wire had one other advantage—it was not so apt to be detected by the janitors, our natural enemies. However, in writing up the idea I stressed only the electrical advantages. Of course there was nothing original in the article; I knew Marconi had used single wires before 1900. Nor, even in my group of amateurs, had I made the discovery. A number of my friends were using long single-wire spans, and I believe they copied the idea from Mr. Fred Parsons. Where he got it I don't know.

Anyway, a controversy raged in the columns of the *Wireless Age* through the July issue, and the method of argument was the same that the broadcast listeners use now. One fellow testified that with a single wire 500 feet long, he had heard the United States Naval station at Guantanamo, Cuba, on such and such a night, so and so loud, whereas with a 100-foot four-wire antenna he had never heard this station, using the same receiver. Another scientist, using a different receiver, had achieved better results with a short multi-wire antenna, and he defended it fiercely, extoling its virtues with poetic fervor, and denouncing the long single wires as frauds. The editors injected some theory into the controversy, and we were all very happy; we saw our names in print each month, our DX records were chronicled and set down for posterity, and we were sure we were right. On this point I was particularly confident, for, early in the debate, I had gone to Doctor Goldsmith, laid the case before him, and received his assurance that, other things being equal, a single 400-foot wire would pick up more and louder 600-meter signals than the same amount of wire in four parallel strands.

In our magazine argument, to be sure, other things were not equal. To this day, however, John Smith argues that he has a better set than Bill Jones, because in a different neighborhood, on a different antenna, on a different night, he heard some broadcast station better (or so he says) than Jones heard it last March. So we were no bigger fools than our successors.

Microphone Miscellany

The Sweet Listeners. Letter received from a cash customer by a well-known station after a wire failure during a field broadcast:

Having tuned-in on your star number every night for the last fortnight and in the midst of the broadcast, heard a series of crashes followed by periods of silence, think it would be better to stick to studio work until your staff learns something about broadcasting. After my experience to-night during ———'s program, I wonder why your staff permits such a butchery of an artist's efforts. If they don't know how to do it, why not experiment with amateurs?

Announcer's Bull. Some time last year we offered valuable prizes for reports of striking verbal bulls by members of the announcing fraternity, but the announcers suddenly became respectable and the prizes went begging. Here, however, is a healthy entrant, from WGBS, New York, Jan. 3, 1926, 4:40 P. M.:

"I am sorry that the Crystal Palace orchestra will not have time to play all the numbers requested. Of course you understand there is a limit both to time *and to human endurance.*" It was a good orchestra.

Marvelous Invention Announced for Twenty-First Time. A. P. dispatch from Washington, D. C., Jan. 16, 1926:

A discovery whereby the sharpness of tuning and selectivity of radio crystal receiving sets is greatly improved was announced to-day by the Department of Commerce.

E. B. Judson, expert in the radio laboratory of the Bureau of Standards, who discovered the improvement, declares that shunting the crystal detector across one-half the inductance coil, causes sharper tuning and greater selectivity.

Moral Effects of Radio. From Baltimore comes another A. P. report, printed in the New York *Times* of Jan. 15, 1926, under the headline, "Forbids Radio at Goucher. President Guth Says It Causes Girl Students to Lose 'Pep.'" The text is as follows:

To-day was bargain day for radio sets at Goucher College. No more will loud speakers or ear phones aid in whiling away the hours between supper time and breakfast. President William Wesley Guth has banned them.

Radio is responsible for late hours and consequent loss of efficiency and "pep," Dr. Guth told the students. In the business world, he said, it is easy to pick out the men who own radios. In the morning their faces tell. Therefore the radio ban, "for the physical as well as the mental welfare" of Goucher girls.

On the other hand, valuable moral lessons are taught over the radio, which may balance the deleterious effect of loss of sleep. An instance from a Japanese newspaper: "Man Attempts Suicide After Lecture by Radio."

After listening to a radio lecture on the horrors of drunkenness and its effects on descendants, Tetso Yashiro, 28 years old, an artist living in Sakurado-cho, Azabu, attempted to commit suicide Tuesday by drinking poison at the Omura restaurant in Imado, Asakusa.

Before drinking the poison the artist drank two bottles of beer and two bottles of sake.

If Mr. Yashiro had bethought himself to get some American bootleg liquor, he might have foregone the poison. That, however, is beside the point. The thing for Dr. Guth to do, obviously, is to re-install the radio sets, and not only that, but to put in a broadcasting station at Goucher. (Heaven will provide a wavelength.) This transmitter will radiate lectures against hip-flasks, the Charleston, cigarette smoking, and petting parties. The girls, attending to these exhortations, will either become good or commit suicide. There will thus be nothing left for Dr. Guth to worry about, and he will have the distinction of presiding over the only collection of chemically pure collegiate women in all Christendom.

Historical Example of Some Record DX Work by Nature

THE energy of most of the sounds to which we are accustomed, is quite feeble, and we are likely to conclude that no sound disturbances exist in nature which are capable of propagating themselves over distances comparable to those of radio or other electrical transmission. Under phenomenal conditions, however, unaided nature is capable of sending sounds, and even material particles, over terrestrial distances as great as those spanned by submarine cables and radio circuits. Sir Ray Lankester, in his book, *Secrets of Earth and Sky*, gives some well authenticated data on the volcanic explosion of Krakatoa in 1883. This volcano is on an island in the Strait of Sunda between Java and Sumatra. The eruption, lasting two days, blew the island high into the air. Some of it, in the form of pumice particles, ascended 30 miles, whence it was carried all over the world by the currents of the upper atmosphere, causing the exceedingly red sunsets of 1884. Over Batavia, a hundred miles distant, the sky became completely dark during the cataclysm. The sea wave which was set up, swept over part of Java and other islands in the East Indies, drowning 36,000 persons. Where it was unimpeded it swept on and was recorded at Cape Horn, 7800 miles distant. At Mauritius, 3000 miles from Krakatoa, the explosions were distinctly audible! Can radio do more?

Radio may not be able to go farther, but it gets there sooner. Inasmuch as sound travels about 1100 feet per second in air it must have taken the noise four hours to reach Mauritius from Krakatoa, whereas a radio wave would cover the 3000 miles in about $\frac{1}{62}$ second. It follows that electricity is the only known solution to the problem of long distance communication, for if sound had to be used directly over a 3000-mile circuit, one would have to wait eight hours for the reply to a question. Two-way conversation, therefore, would require more patience than the human race possesses, judging by the experience of telephone operators. Of course, when it comes to light waves, that part of nature outside of man equals his radio waves in speed and far transcends them in magnitude. Light waves come to us over inconceivable distances, scarcely to be expressed even in such astronomical units as light years—the distance traveled by a light wave, moving 186,000 miles a second, in one terrestrial year. Our little toy radio waves reach their destinations in trifling fractions of a second, because their energy dies down to insignificance after they have gone a few thousand miles, a distance scarcely worth mentioning to an astronomer.

Radio Lingo

Broadcasting Transmitters' Cant

A NEW terminology is growing up in the broadcasting stations. The operators say, "How's the pick-up?" referring to the placing of microphones. "You're on the air" goes over the wire line to a remote point as a warning that broadcasting of an outside event is to begin. They say, "Give him the air," and "Take him off the air," "Did that go out?" and many other phrases along these lines.

A broadcasting engineer, listening critically to the reproduction of an orchestra, may make the remark, "The violins are down ten miles." "Down" means "weak" in telephone phraseology. "Ten miles" denotes the degree of weakness—telephone engineers speak of amplification in terms of miles of standard cable. He means, then, that the violins in the orchestra are as weak as if they had to go through a line ten miles longer than the rest of the orchestra, and that this must be corrected.

Terms Derived from Physics and Engineering

RADIO is high speed acoustics. Speed up a sound vibration to a hundred times, let us say, and you have a radio oscillation. It is only natural, therefore, that many of the technical terms and inventions of radio have originated in the field of acoustics.

The fundamental concept of "tuning" is an instance. Musical instruments were "tuned" long before radio was dreamed of. We speak of electrical "resonance" nowadays when its only indication may be the silent movement of a pointer across a scale, but the origin of the word is obvious: "re-sound," to respond sympathetically and audibly when tuned to the same period, as a pair of properly adjusted violin strings. The quality of a broadcasting station's "modulation" is discussed; the term is an old one to students of singing and voice formation—"quality" itself is an expression used in music and the physics of sound. As for inventions, Fessenden's heterodyne, for example, came directly from acoustics. Everyone is familiar with the fuzzy quality of two discordant notes on a piano. This roughness is due to "beats" or periodic building up and neutralization of the energy of the two waves. In radio an inaudible oscillation may be detected with the aid of a local oscillation set to "beat" with the incoming frequency at an audible rate. Thus we speak of "beat-reception," "beat-frequency," and "zero-beats" in radio, the last named being the method by which a lot of distance records are more or less reprehensibly made by novice listeners, since with this condition re-radiation and interference with other listeners is bound to result.

"Microphone" is a telephone term. "Cross-talk," which is supplanting the vague expression "interference" in broadcasting, is also of telephone origin. "Loading coils," used in radio to tune to a higher wavelength than the normal range of a set, receive their name from Professor Pupin's contribution to long distance telephony—the placing of inductances along the line to improve speech quality and loudness.

Many radio fans have wondered why a gas-content vacuum tube is called a "soft" tube, while the highly evacuated bulbs are termed "hard." These expressions originated with the X-ray folk. A highly exhausted X-ray tube was found to give out "hard" or highly penetrative rays, while in the presence of gas, "soft" or less piercing radiation resulted.

WE WERE PROUD OF OUR ARTICLES PUBLISHED IN RADIO MAGAZINES

B-POWER

By

NOE H. TYAR

HEYWOOD BROUN writes an interesting, witty, and occasionally instructive column for the New York *World* and other papers. He might have been persuaded to do this one. But it would have been a trying experience for even the versatile and clever Heywood.

Not so with the present author, however. He feels an advantage over Broun, that would put even that seasoned veteran in the shade; if any shade can be found to hide a man of his reputed dimensions and admitted luminosity.

To Broun the Raytheon B-power supply is a sort of hazy entity which he heard one of his friends mention at luncheon yesterday. He thinks that his radio set is naturally whimsical, and while the music isn't just what one is accustomed to from a good press seat on the aisle, it is about what one expects from a radio. Of course it's a little bit flat and tinny sometimes, but if friends are coming in one can always pep it up with a new set of B-batteries.

What a handicap! Not even if Broun spent a whole week-end investigating the advantages of central station power over inefficient B-battery power would he be competent to write convincingly for this column. Nor would any literary person, however talented, unless he possessed that magic touchstone of enthusiasm which we (editorially speaking) are privileged to enjoy.

And that touchstone is no happy bent for the technical details which prove the superiority of the Raytheon B-power units. Far more important, far more convincing than that is the honest pride of ownership, the simple joy of throwing the switch that turns on the power. This is the daily revelation that has made every Raytheon B-power owner a more enthusiastic booster than a newspaper columnist would dare to be, even over his own college football team.

Evolution Crops Out Again

But let us digress since we are surely to be allowed the license and freedom from coherence which is the implied right of all who write "columns."

Have you ever thoughtfully considered the evolution of the candle? Yes, the candle, the kind great-grandfather used during those long winter evenings to teach grandfather his sums. (Little boys brought their lessons home in those days.) Do you know it was surprising the amount of light folks could get out of one of those old tallow dipped wicks. To be sure, it sputtered and flickered and had a habit of burning dim and dimmer just as great-grandfather reached the interesting part of the piece he was reading aloud to the assembled family. But that old tallow dip played its part in brightening the small corner where it stood.

Manufacturing methods soon made possible the candle mold so that a dozen or more could be made at one time. This reduced the cost somewhat and increased their reliability and brightness. It wasn't long until they were made in larger,

RAYTHEON

long-burning sizes for the big living room. Folks had pretty sound ideas of how to get the most out of things in those days. The wiser ones even put a reflector back of the flame to conserve what energy there was and use it to the best advantage.

But candles had their drawbacks, and while they were handy for lighting a pipe, they were apt to set curtains or carpets afire, to say nothing of the never-ending replacement problem. So when the oil lamp came along it was immediately adopted by the better homes as the last word in illumination. Surely such a steady glow combined with the ease and economy of refilling the bowl with lamp oil was all anyone could wish.

Yet the lamp rapidly became obsolete in all except the farthest rural districts, and to-day we have illumination that is limited in its intensity only by the power of the equipment we see fit to install. Surely no one who has known the satisfaction of the steady glow that is now available at the turn of a switch would consider for a moment the uncertain old candle.

Now About B-Power Units

But the history of the candle is of interest to us at this time only as it sheds light on its successor to fame—the B-battery. Does not the evolution of the candle, the oil lamp and the modern electric light parallel the development of the dry B-battery, the storage B-battery, and the modern B-power unit to a remarkable degree?

To be sure dry B-batteries, like candles, can be conserved by judicious use, and the storage type B-batteries do improve the quality of reception. But to the owner of a Raytheon B-power unit it is no more a B-battery eliminator than the Mazda lamp is a candle eliminator. The Raytheon B-power unit marks a new era in radio, a distinct advance in the art that is immediately evident to those who have had the foresight to install one.

Is There a Reason?

Why is Raytheon B-power better? Folks have an odd trait of wanting to know the whys and wherefores of things. In the days when electric street cars were replacing the old horsecars children had the embarrassing habit of looking up into their papas' faces and demanding, "What makes it go?" And many a proud father floundered miserably in the vain struggle for an explanation.

But here the answer is not far to seek. A Raytheon B-power unit gives better reception principally because it supplies ample voltage, a higher voltage and more power than you would find economical to obtain from B-batteries. This reserve power, which is as steady from night to night as are your electric lights, is made possible by the new rectifying tube, Raytheon type B.

And people are becoming more and more critical in their judgment of quality. We once heard a music lover say that if he were seated blindfolded in a room and some one in that room struck but one chord on the piano, he could tell positively whether or not that person was Paderewski. Those who know the unique quality of Paderewski's touch will not be inclined to doubt the possibility. But how many of the best music critics could listen to a piano concert over the average radio and judge whether it was being played by a master or by a student from the local conservatory? Even the best receivers, with the latest model loudspeakers, often lack the final touch of realistic quality.

The Second Reason

And that final touch will usually be found in the B-power supply. Not only must the voltage and power be ample, but the power must be fed to the receiver through the right circuit. Here we have the second reason why Raytheon B-power units are better. They use a filter circuit which is scientifically balanced to allow all the notes to be uniformly amplified. The low notes come through in their normal volume.

The third, and not least importtant, reason for the high quality of Raytheon B-power units is the group of manufacturers who sponsor them. These companies, of long established reputation for square dealing, stand back of their products and they could ill afford to come on the market until they had taken every precaution to make sure that the new product was right. Some of the interesting laboratory work that is done to safeguard this quality will be discussed in a future article.

As for you, Mr. Broun

Oh, yes, we nearly forgot about our columnist friend who is struggling along with his B-batteries. Well, Mr. Broun, if you'll let bygones be bygones and give us a fair chance to prove that you *are* slightly behind the times, we'll just ask you to install a Raytheon B-power unit to-night. If it isn't all that has been claimed, drop a postal to us care of Radio Broadcast and we'll buy the darn thing back, spot cash, no questions asked. The office boy has been snooping around for a second-hand one, anyway.

RAYTHEON

THE GRID

A Department Devoted to Solving the Problems of our Readers

QUERIES ANSWERED

1. MY RECEIVER TUNES BROADLY. HOW MAY I CORRECT THIS?
W. A. S.—Cincinnati, Ohio.

2. HOW OFTEN SHOULD I CHANGE THE ELECTROLYTE IN MY STORAGE BATTERY?
M. B. L.—New Orleans, Louisiana.

3. YOU SAY THE WESTERN ELECTRIC CONE IS A LOW IMPEDANCE SPEAKER AND THE WESTERN ELECTRIC COMPANY SAYS IT'S A HIGH IMPEDANCE CONE. WHO'S RIGHT?
P. J. F.—Philadelphia, Pennsylvania.

4. I AM BOTHERED WITH A PERSISTENT SINGING NOISE IN MY RECEIVER. HOW CAN IT BE ELIMINATED?
T. S. L.—Baldwin, Long Island.

5. MAY I HAVE A CIRCUIT DIAGRAM FOR AN INTERFERENCE FINDER?
B. J. S.—Brooklyn, New York.

6. THERE IS PRESENT IN MY RECEIVER A CONTINUAL BUZZING NOISE, EVEN WHEN GROUND AND ANTENNA ARE DISCONNECTED. CAN YOU HELP ME TO ELIMINATE IT?
C. E. E.—Toledo, Ohio.

7. I CAN RECEIVE ONE STATION ON TWO POINTS ON MY SUPER-HETERODYNE'S OSCILLATOR DIAL. WHY?
B. F. D.—New York City.

8. IN FIG. 8 ON PAGE 455 OF THE FEBRUARY RADIO BROADCAST, YOU SHOW A NINE-VOLT C BATTERY ON THE LAST TUBE WITH ONLY 90 VOLTS ON THE PLATE. IS THIS CORRECT?
K. H. S.—Miami, Florida.

9. THERE ARE SEVERAL METHODS OF CONNECTING THE GRID LEAK. WHAT DETERMINES WHICH CONNECTION TO USE?
R. S. J.—Detroit, Michigan.

1. SHARPER TUNING

UNDOUBTEDLY there are many constructors who, after completing a receiver consisting of a stage of tuned radio frequency amplification, a detector, and audio amplifier, have noted that the dial of the condenser tuning the secondary coil of the antenna circuit usually logged twenty or so degrees different than the condenser dial used to tune the r. f. transformer secondary.

This condition may be caused by a number of things but usually it is because the antenna coil is too closely coupled to the secondary. This close coupling not only shifts the tuning point but broadens the tuning because the resistance of the secondary is increased, due to the absorbing effects of the closely coupled primary circuit.

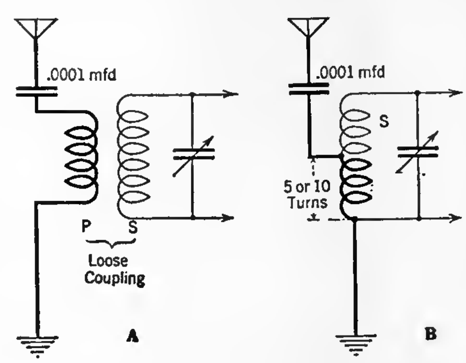


FIG. 1

The remedy, of course, is to loosen the coupling between primary and secondary. Where maximum selectivity is desired, a .0001-mfd. fixed condenser may be inserted in the antenna lead. Fig. 3 A shows how this is done, while B shows how the antenna may be directly connected to the secondary for sharp tuning.

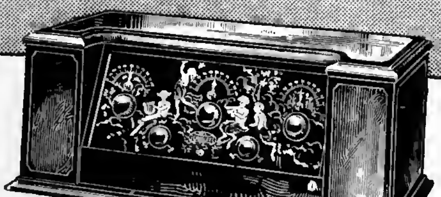
2. STORAGE BATTERIES AND ELECTROLYTE RENEWALS

WHEN one buys a radio receiver and its accessory equipment, it is expected to function with as little care or trouble as possible. If the set is one run on dry batteries, these will require replacement more frequently than will a storage battery because the latter has the property of being rechargable to its former state of usefulness. Storage batteries function on the principle of a liberation of electrical energy by a chemical change which takes place within the cells comprising the battery.

The three fundamental parts which go to make up a generator of electrical energy, such as the storage battery, are the positive plates, the negative plates, and the electrolyte. The first two are fixed elements encased within the cell container, and therefore are, for all practical purposes, non-renewable. The electrolyte is a combination of water and sulphuric acid (for lead type cells). The specific gravity of this combination changes during the discharge of a battery, and during the recharge is restored to its original value. Now, during this charge and discharge, the water mixed with the acid evaporates more quickly than the acid; therefore, to keep the level of the electrolyte at such a point as to be effective over the whole surface of the other two plate elements, more water must be added to compensate for that lost through evaporation. Distilled water should be used for this operation. Also, about once a year, it is wise to have your battery thoroughly cleaned out and refilled with a new solution of fresh acid and water.

The cleaning process is necessary because, after constant use (and when a too high charging rate is used) partial disintegration of the plate elements takes place. That is to say, the active material which is compressed into the meshed plate forms during manufacture, becomes loosened, and frequently falls to the bottom of the container. If enough material falls, there is the possibility that it will reach up to a level with the bottom of the plates and in time cause short-circuits from plate to plate. A certain amount of dust is also liable to fall into the battery when the vents are removed during

Four New Radios

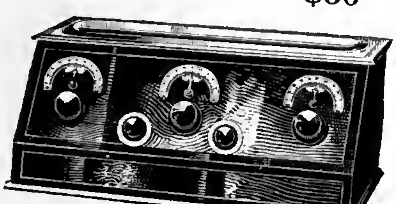


The Crosley 5-Tube RFL-75

Absolutely balanced radio frequency amplification. Non-oscillating under any handling. Exquisite two-tone mahogany cabinet—satin finish. Decorated panel with rose-gold metal fittings. Cabinet holds necessary dry cells Price without accessories . . . **$75**

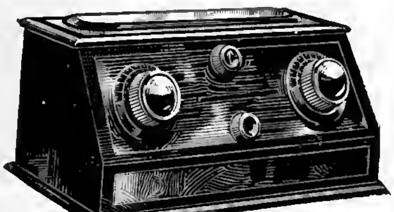
The Crosley 5-Tube RFL-60

Same as RFL-75 but in compact cabinet only 17½ inches long. Truly marvelous selectivity, sensitivity and purity of tone. Art panel—solid mahogany cabinet—rose gold fittings. Price without accessories **$60**



The Crosley 5-Tube 5-38

All the volume, selectivity, sensitivity and fine tone in the best 5-tube set you've heard—plus the CRESCENDON. Two toned mahogany finished cabinet—daintily striped in gold. Price without accessories . . **$38**



The Crosley 4-Tube 4-29

A beautifully designed set—both to ear and eye. Crescendon equivalent to one or more additional tubes of radio frequency amplification. Two toned mahogany finished cabinet. Price without accessories **$29**

West of the Rockies add 10% to all prices

"If inexperienced in radio, be sure your first set is a Crosley"

It takes neither practice nor mechanical skill to tune in stations all over the country. Children and old people operate Crosley radios easily.

They are fool proof.

They are inexpensive. They don't tie up a lot of money.

They have proven their efficiency over a period of years. Thousands of letters report remarkable demonstrations. Hundreds of thousands of sets sold substantiate all claims to excellence.

They are made by a reliable, well known and financially strong concern, that guarantess them . . . absolutely.

The easy operation, tone and volume of these four new Crosley sets delight, not only the expectant beginner; they arouse the most confirmed radio lover to realization that Powel Crosley, Jr., has again made a revolutionary improvement in radio.

And the RFL sets possess *true* cascade amplification. For Crosley has utilized an entirely new patented circuit which achieves cumulative amplification, actually approaching the theoretical maximum efficiency per tube.

The Crescendon

In the 4-29 and the 5-38, the introduction of the Crescendon enables these two highly efficient radios to give almost unbelievable results and has lifted them away and beyond all competition.

The Crescendon is an exclusive Crosley device for increasing the weak signals of distant stations to full volume tones without distortion. Yet with these sets, loud nearby stations can always be softened practically to whispers.

Their striking beauty will please your eye, and your ear will introduce to you new qualities in radio, which you are sure to pronounce a revelation.

See the new Crosley sets at your dealer's or write Dept. 20 for literature.

Crosley manufactures radio receiving sets which are licensed under Armstrong U. S. Patent No. 1,113,149, or under patent applications of Radio Frequency Laboratories, Inc.

THE CROSLEY RADIO CORPORATION
Powel Crosley, Jr., *President*
CINCINNATI, OHIO
Owning and Operating WLW; first remote control super-power broadcasting station in America

CROSLEY RADIO

BETTER—COSTS LESS · · FOR THE ENTERTAINMENT CORNER the charging process, etc. A few general hints for the maintenance of a storage battery are as follows:

Keep the level of the electrolyte about ¼ inch above the tops of the plates.

Don't charge your battery at a higher rate than that specified by the manufacturer (usually around 5 amperes.).

Renew your electrolyte once a year.

During charge, remove the vents from the cells to liberate and dissipate the gases formed during the charge period.

Keep the lead terminals of the battery well greased with vaseline.

Keep the tops of the containers and the wood retaining box dry. If this is not done, the action of the acid upon the wood will cause rot.

If acid spills upon anything, cleanse the object with household ammonia. This will insure against burns, rotting, and the other injurious effects of sulphuric acid.

3. CONE LOUD SPEAKER IMPEDANCES

SOME time ago RADIO BROADCAST showed how the mechanism of the cone loud speaker, such as the Western Electric 540AW, could be altered so as to improve tone quality, etc. It was stated then that this particular cone was a low impedance one. The Western Electric Company says that its 540AW cone is a high impedance cone, however. In comparison to the old 10D horn type loud speaker manufactured by the Western Electric Company, the 540AW cone is a high impedance unit, its resistance being approximately 4000 ohms. The impedance of the former is about 2000 ohms. But when compared with other loud speakers of the cone variety now obtainable, the 540AW is a low impedance cone since all the others have a higher impedance.

To use the Western Electric cone in a circuit correctly and efficiently, where UV-201-A tubes are used throughout, a 9 to 1 output transformer should be employed to compensate for the difference in impedance between the tube and the cone. When one of the 112 type tubes is employed in the output position, no output transformer is required, for the cone and this tube very nearly match, thus insuring satisfactory tone quality.

4. ELIMINATING AUDIO AMPLIFIER NOISES

WHEN there is present in your loud speaker or phones a steady, unchanging, singing noise, you may be sure that the trouble is somewhere in your audio-frequency amplifier.

By grounding the minus A terminal of the storage A battery, this noise may often be eliminated. Sometimes this is not sufficient, so other means for eliminating the noise must be employed.

If the transformers in the audio amplifier have metal cases, connect them together, and then run that connection to the grounded terminal of the receiver. If these transformers have no metal cases, connect their cores together with a wire and lead this to the ground binding post.

Often, by wrapping a wire around the cord to the loud speaker or phones, and grounding the lower side of this wire, the singing noise may be prevented from entering into the loud speaker.

The wrong way to control the volume of your signal in the loud speaker is to turn down the rheostat which regulates the audio tubes. When the voltage to the audio tubes is lowered beyond the rated operating point, the impedance of the tube is increased. This creates an unbalance between tube and transformer with the result that the lower audible frequencies are discriminated against. The reasoning behind this statement is clearly explained in the articles by Keith Henney in the December, 1925, and February, 1926, issues of RADIO BROADCAST.

It is well for the operator of a receiver to see to it that not only does he control his volume output in some other way, but that his A battery is not allowed to drop considerably in voltage.

One of the best types of volume control is that where a high variable resistance shunts the secondary of one of the audio transformers.

5. AN INTERFERENCE FINDER

THE recent articles in RADIO BROADCAST on the subject of interference, which were supplied through the courtesy of the Canadian Government, have caused considerable interest and a demand for a circuit satisfactory for use in a receiver designed to locate radio disturbances.

We print herewith the circuit diagram for a simple portable affair which is exceedingly successful for this type of work.

It consists of a tuned loop radio-frequency amplifier and a crystal detector, the latter feeding into a pair of phones. The circuit, Fig. 2, is self-explanatory. Standard broadcast coils are satisfactory for the coupling unit between the r.f. stage and detector. If a gang condenser is employed to tune the loop and detector secondary, then the number of turns on the loop must be adjusted so that the dial readings, had separate condensers been employed, would be the same for both loop and r.f. secondary. It is advisable to employ a UV-199 tube so that dry cells may be used for the A battery supply. This makes for better portability.

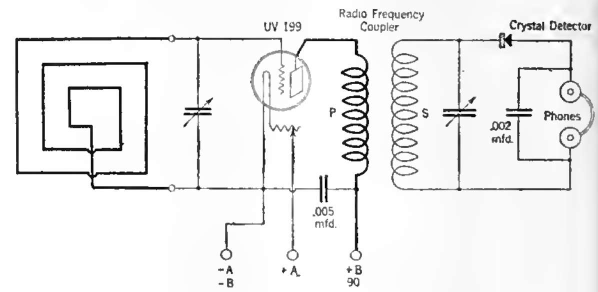


FIG. 2

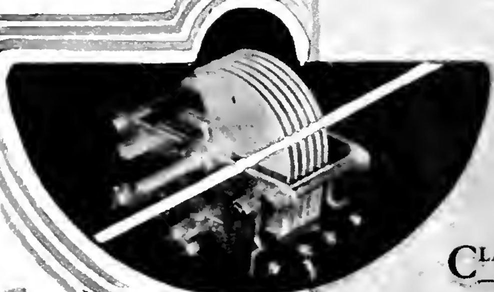
6. RECEIVER NOISES AND BYPASS CONDENSERS

USUALLY it is not a difficult job to locate and remedy the noises caused by a receiver if systematic search for the trouble is instituted. However, there are some cases that prove baffling. In general, the search may be classified into three groups, i.e., noises coming into the set from without; noises generated in the receiver; and noises caused by the batteries.

By disconnecting the antenna or ground, or both, while the set is in operation, the noise will usually cease if it comes from the outside. A noise inside the receiver may be usually attributed to defective parts, poor wiring, or incorrect location of the apparatus. All this can be determined by a sensible test. Now noises not located by the above observations are not necessarily caused by defective batteries as the following instance will show.

Every possible test had been made. Wiring checked, new tubes tried, new batteries, but still the noise, one of a crackling intermittent nature, persisted. After trying every test, the fixed bypass condensers were inspected and subjected to a circuit test. Here it was found that evidently one had become punctured causing an intermittent spark-over of the B

Cardwell



The Taper Plate Type "E" with straight frequency tuning characteristics

Acclaimed!

By Every prominent engineer who has seen them, Taper Plate Type E Condensers represent the foremost step in condenser design since the original low-loss metal endplate, first made by Cardwell five years ago.

CLAYTON—Cockaday—Lynch—Best—Wing—Neely—the list of those who specify Taper Plate Cardwells reads like a roster of the greatest Technical Editors of Radio.

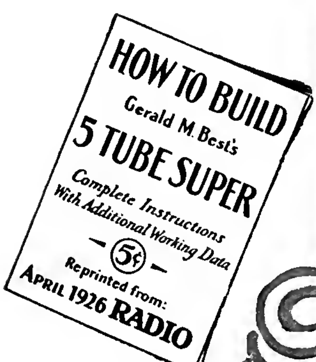
The Taper Plate Type E Receiving Condenser is designed to be practical rather than theoretically perfect. Its tuning characteristic is straight frequency over the lower part of the scale, tapering to approach straight wave-length at the top. Full size plates, far heavier than ever used before, assure positively permanent calibration.

The Type C approaches straight frequency on the very low portion of the scale only, changing to a modified straight wavelength as capacity is increased.

Type "C"	Type "E"	Capacity (Mmfds.)	Price
168-C	167-E	150	$4.00
170-C	168-E	250	4.25
171-C	169-E	350	4.75
172-C	192-E	500	5.00

The Allen D. Cardwell Mfg. Corp.
81 PROSPECT STREET, BROOKLYN, N. Y.

The Type "C" has a modified straight wave length tuning curve



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Condensers

"THE STANDARD OF COMPARISON"

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battery potential which it directly shunted. After a new bypass condenser was installed, there was no further trouble.

7. TWO POINT TUNING WITH A SUPER-HETERODYNE

QUESTION after question is received from owners of super-heterodynes who wish to know why it is that a station may be received on two places of the oscillator dial. To provide an easily understandable answer requires a review of the principles of operation of a super-heterodyne.

An incoming signal as in A, Fig 3, first passes through the detector or mixer tube. An oscillator capable of generating a signal whose frequency is greater by a definite amount than that of the tuner unit of the super-heterodyne, sets up a signal which is also passed into the detector tube, as in B, Fig. 3.

There are then, two signals being passed to the detector tube which combine, or beat, and set up a third signal, C, Fig 3. This third signal is equal to the difference of the first two signals mentioned. As an example, let us assume that a signal of 1000 kc. (300 meters) is being received on the loop of the super-heterodyne. Now, if the oscillator is adjusted so that its frequency is either 990 kc. or 1010 kc. it will differ with the 1000-kc. signal by 10 kc. This 10-kc. difference is equal to 30,000 meters, and the radio-frequency amplifier, otherwise termed the intermediate-frequency amplifier, in this instance should be so designed as to pass signals slightly more or less than 30,000 meters. The reason that the intermediate amplifier is not tuned sharply to exactly 10 kc. in this case is to prevent cutting off of the side bands of the carrier. A 5000-cycle leeway should be allowed on either side of the determined frequency. Thus, the intermediate amplifier should be capable of covering a frequency band of from 5000 to 15,000 cycles in what is known as a 10-kc. super-heterodyne.

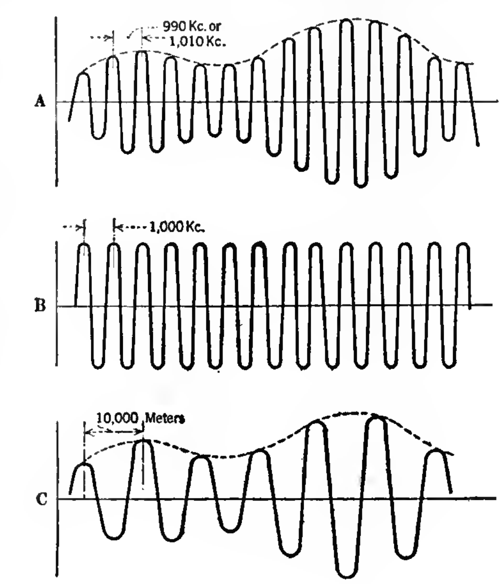

FIG. 3

The reason, then, for being able to listen to a station at two places on the oscillator dial is obvious because, with the loop tuning control set at the station desired to be heard the oscillator can be tuned to a frequency either 10 kc. less or more than this incoming frequency.

8. CORRECT GRID BIAS VOLTAGE

IN OPERATING a receiver it is essential that all the tubes be used with the correct voltage of grid bias. This is particularly true of the output tube of a receiver. The various other tubes in the audio amplifier should be operated as voltage amplifiers, whereas the last tube functions as a power amplifier. The power depends upon the amount of current available in the plate circuit of the tube and, with decreasing C battery, the plate current, and therefore the power, increases. It therefore becomes essential that the lowest value of C battery be used as is possible without overloading the tube. The tube will overload if the peak value of the signal voltage becomes greater than the voltage of the C battery.

Since it is seldom that a signal of more than $4\frac{1}{2}$ volts is impressed upon the grid of the last tube, a $4\frac{1}{2}$-volt C battery is generally sufficient, and this is about the largest signal that a UV-201-A type tube can handle and still give an undistorted output. It is commonly supposed that the value of C battery depends upon the amount of plate voltage, but this is not especially true of power amplifiers. It would be truer to say that the value of plate voltage depends upon the C battery. In other words, the C voltage should have a value equal to the peak value of the signal voltages and then sufficient plate voltage should be placed on the tube so as to handle satisfactorily the signal that is being impressed on the grid.

For all ordinary cases these conditions are fairly constant, so that average values can be used. For a receiver of the type mentioned in this question, a value of $4\frac{1}{2}$ volts on the last tube would give quite satisfactory results.

9. GRID LEAK CONNECTIONS

THERE are two common methods for connection of the grid leak. One is to connect this resistance directly across the grid condenser, while an alternate method is to connect the resistance from the grid of the detector tube directly to the positive side of the filament. The former connection is used in most circuits but for some hook-ups it cannot be used.

An example of the type of receiver where this connection cannot be used is the RADIO BROADCAST "Universal," and it becomes necessary to connect the resistance directly from the grid of the tube to the positive filament. In this circuit, if a leak were placed directly across the condenser, the high plate voltage used on the r. f. amplifier would be impressed on the grid of the detector tube, and would prevent this unit from operating.

GRID INQUIRY BLANK

Editor, The Grid
RADIO BROADCAST
Garden City, New York

DEAR SIR:

Please give me the fullest information on the attached questions. I enclose a stamped envelope.

☐ I am a subscriber to RADIO BROADCAST and therefore will receive answers to my queries free of charge.

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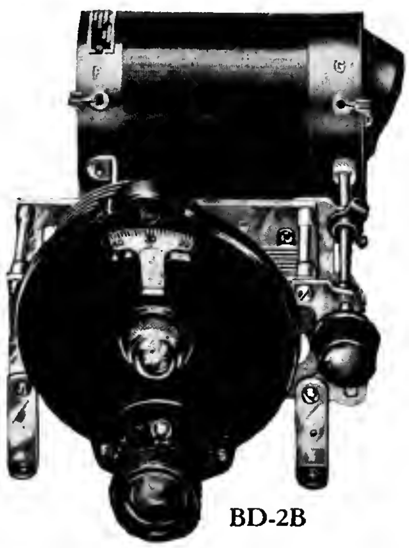

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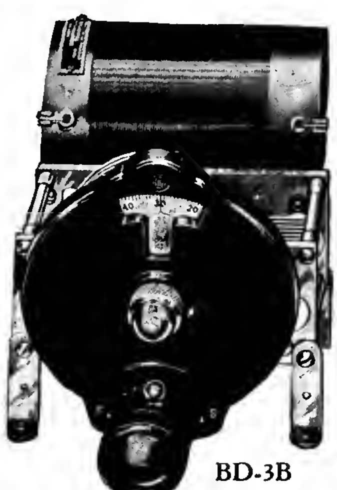

BD-3B

★

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A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prizewinner for the last period is announced at the foot of page 78. Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department, RADIO BROADCAST, *Garden City, New York.*

WESTERN ELECTRIC CONE WITH A SUPER-HETERODYNE

WHEN I purchased a Western Electric cone speaker for my Silver-Marshall portable super-heterodyne, I was disappointed with the results. The cone gave a very sweet, pure tone when operated at low volume, but rattled and distorted if the set was tuned in to a volume loud enough for an ordinary living room.

By installing one of the new UX-120 tubes in the second audio stage, and making suitable wiring changes, I have been able to eliminate this trouble and to realize the tone possibilities of this speaker at full volume.

This cone is designed for use with its companion amplifier using tubes whose plate-filament impedances are in the neighborhood of 6000 ohms, and with which it will give wonderful results, particularly when used with the higher plate voltages. Best results are not to be expected with average sets using UV-201-A or 199 tubes which have impedances of 12,000 to 15,000 ohms. Until recently the answer has been to install a power tube in the last audio stage, such as the UV-202, 216-A, or VT-2. These tubes operate at relatively high A and B battery current, however, so that the user of 199's would have to give up the use of dry cells as his whole current source, and make a considerable battery investment.

The new UX-120, however, operates on .125 amps at 3 volts, and is rated as having an impedance of 6,600 ohms. Some alterations are required in the installation of this tube, which should be brought to notice with reference to the accompanying diagram, Fig. 1.

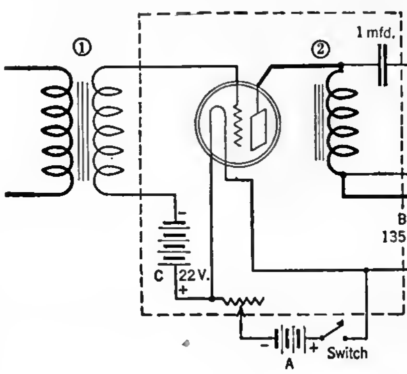

FIG. 1

Here, 1 marks the last audio transformer of the set, preferably one which gives uniform amplification over a wide range. Disconnect the leads to the secondary and hook up as shown. The 22½-volt C battery should be provided with taps so that its voltage can be adjusted to obtain the best tone, particularly if less than 135 B volts are used. The C plus lead is on the filament side of the rheostat.

Best results are obtained with the Western Electric cone when only alternating current passes through its windings. The secondary of an audio transformer is therefore connected as shown at 2, to bypass the direct current, and a 1-mfd. condenser is placed in the output lead.

If, by chance, the A and B minus terminals of your set are connected together, don't forget to modify your connections to avoid shorting your A battery.

An adapter is available for mounting the UX-120 in a 199 socket, if there is room inside your set. Some may prefer, however, to build a separate power amplifier unit, in a separate ten-inch cabinet, which makes a neat arrangement and avoids making permanent changes to the set. The apparatus in this unit is shown inside the dotted lines.

Although greater volume can, of course, be obtained by using a larger power tube and 350 B volts, the arrangement described permits the unusual clarity and sweetness of tone to be realized while still using dry cells as a source of current.

J. T. LANSING,
Montclair, New Jersey.

USING HEAD PHONES WITH THE ROBERTS RECEIVER

THE only criticism that might be lodged against the Roberts reflex circuit is that the volume of sound produced by this excellent receiver is too great for those listeners who do not wish to employ a loud speaker always, but prefer to use head phones. However, this defect is easily remedied. It is only necessary to place a double-circuit jack in the

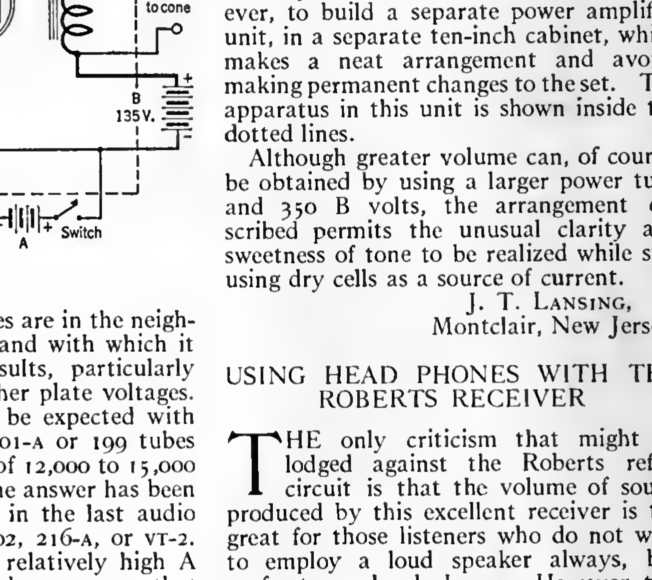

FIG. 2

plate circuit of the detector tube, as shown in Fig. 2. No other change is necessary in the three- or four-tube set, but in the two-tube set the regular jack, which is single, will need to be replaced with a double-circuit jack so that the plate circuit of the amplifying tube will be closed when the plug is pulled out.

When the phone plug is inserted in the jack in the plate circuit of the detector tube, the reflex feature of the Roberts set is automatically eliminated.

This arrangement affords an easy and accurate method of neutralizing the radio-frequency amplifying tube as explained by Mr. M. B. Whitney in this department for August, 1925.

In this connection it might be well to add that the neutralizing condenser should be a first-class article. It has to stand the pressure of the entire B battery voltage, and the slightest leakage or arcing across it will be the cause of much trouble. Unless the amplifying tube is accurately neutralized, energy will be fed back when the tickler is advanced up to the secondary coil, and signals will become mushy or distorted. It would be poor economy to use a make-shift neutralizing condenser.

W. C. Lane,
Sanford, North Carolina.

AN EMERGENCY REPAIR WITH IMPROVED RESULTS

One evening my set, which had been developing some curious noises, suddenly ceased operating. A little investigation showed that the primary winding of the second audio transformer was broken. This was annoying as there was a program on the air that we wished to hear. The loud speaker was plugged into the first stage. This gave fair volume, but not enough for the deaf member of the family, so I decided to change the second stage to impedance coupling, meanwhile leaving the set in operation.

The primary of the damaged transformer was disconnected, and the secondary was hooked up as a choke coil, one terminal being joined to the plate of the preceding tube, the other terminal to the B plus. A blocking condenser of .001 mfd., the only one in the house, was connected between the plate end of the choke and the grid of the following tube. There being nothing in the shape of a grid leak around, I fell back on the good old pencil mark on a small strip of fibre board to connect the grid to C minus. All this took about fifteen minutes.

With a c-299 tube in the socket, 90 volts of B and 4.5 of C battery, the loud speaker was then plugged into this makeshift second stage. The result was absolutely astonishing. The volume was almost as great as from the undamaged transformer. The music could be heard in rooms on the second floor of the house. The quality of the reproduction was far ahead of any transformer I have ever heard. It is needless, perhaps, to say that I shall not replace that transformer, but that I shall also convert the first stage to impedance coupling.

C. O. Southard, M. D.,
San Francisco, California.

INCREASING THE FREQUENCY RANGE OF YOUR SET

Broadcast listeners have, for some time now, been troubled by the crowding of stations at the higher frequencies of from 1500 kc. to 1000, kc. (200 to 300 meters). This may be avoided by using straight line frequency condensers or dials. But if you are the user of a two circuit tuner, as shown in Fig. 3, the stations between 1500 kc. and 1000 kc. may be separated very easily by simply placing a 30-turn honeycomb coil across X and Y. With this arrangement my set now tunes from 1000 kc. to above 2000 kc. (150 to 300 meters), and the stations between 1500 kc. and 1000 kc. come in at the top of the condenser scale, and are widely separated.

Using an "Uncle Sam" tuner in the circuit my set tunes from 545 kc. to 1500 kc. (550 to 200 meters). By shunting a 25-turn honeycomb coil across the secondary (across X and Y), the set tunes from 1200 kc. to 3000 kc. (250 to 100 meters), and with a 10-turn honeycomb coil, it tunes from 2400 kc. to 5500 kc. (125 to 50 meters).

By putting condensers of .00025, .0005, and .001 mfd. across X and Y, the set tunes from 545 kc. to 300 kc. (550 to 1000 meters). The 300 kc. frequency band (1000 meter wavelength) is obtained by shunting both the .001 and .0005 mfd. fixed condensers across X and Y. Note the 10-megohm grid leak. The set will not oscillate over the entire 300 kc. to 3750 kc. (1000 to 80 meters) band if a lower resistance is used here. Although I use a WD-11 tube, the set will work just as well with any of the other types. I use an outdoor aerial 140 feet long and 30 feet high, but when receiving the frequencies above 2000 kc., a 20 feet indoor aerial works just as well as the large one. I have the three condensers and two coils attached to battery clips and mounted on my panel so that they may be easily attached to X and Y. Using the coils and condensers mentioned, the set will tune higher than 3750 kc. and lower than 300 kc., but it will only oscillate over the frequency band mentioned.

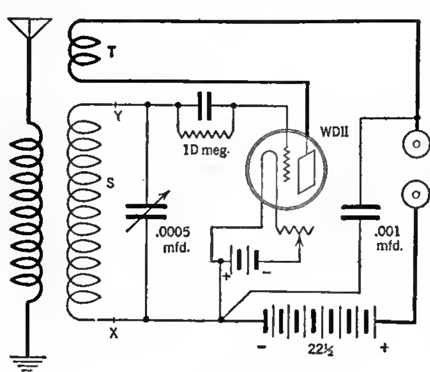

FIG. 3

It will be seen that, when putting the coils or condensers across X and Y, no other changes than a change in frequency range takes place in the set. The primary and tickler coils both feed into the old secondary.

By fixing one's set in the manner described above, many stations other than broadcasting stations may be heard. Ship stations, commercial stations, amateur stations, and short-wave broadcast stations, may be heard. Station 2 XI, rebroadcasting WGY's programme on 2700 kc. (109 meters), is often heard louder than the WGY broadcast program.

William G. Talley,
Richmond, Virginia.

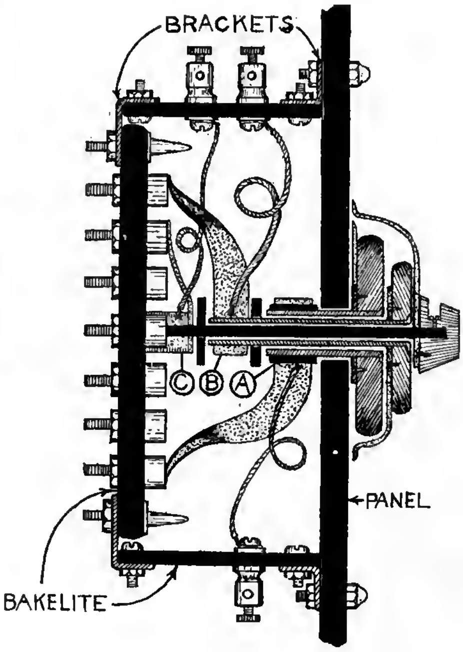

FIG. 4

A TREBLE BACK-MOUNTED TAP SWITCH

SOME people use the Reinartz hookup because it is easily constructed by the home builder. However, the trend is now toward nice bare panels without even bezels, so one can watch the genie of the tube get in his work, and the Reinartz certainly has a bunch of knobs and dials to jiggle. A combination back-mounted switch, as illustrated in Figs. 4, 5, and 6, is an innovation and improvement with this or any other hookup requiring two or more sets of taps.

The necessary taps and stops are mounted on a disc of bakelite $2\frac{1}{2}$ inches in

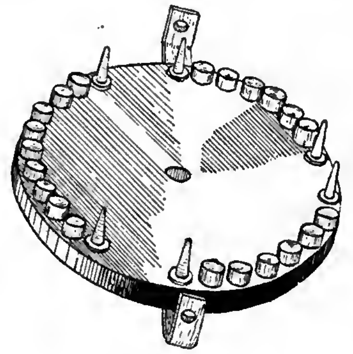

FIG. 5

diameter. The brass shaft for A in Fig. 4 is $\frac{5}{16}$-inch in diameter and $\frac{3}{4}$-inch long. The brass shaft for B is $\frac{3}{16}$-inch in diameter and $1\frac{1}{2}$ inches long. The bakelite shaft for C is $\frac{1}{8}$-inch in diameter and $2\frac{3}{4}$ inches long. The shafts fit tightly in A and B, and are swaged in with a punch. A strip of heavy paraffin paper or varnished cambric insulates the switch lever from the shaft on A. The switch lever on C was taken from

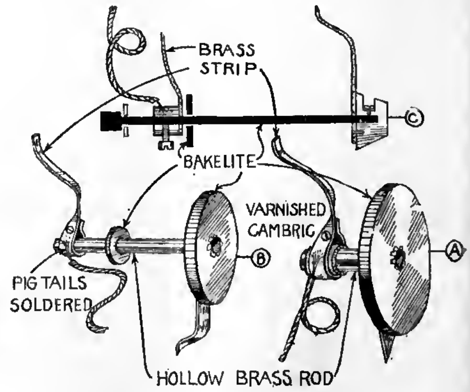

FIG. 6

an old rheostat. The pigtails are soldered to the levers.

Markings with white ink on the front of the panel indicate the position of the levers on the points.

The diagram clearly shows the method of mounting the assembled unit on the panel.

J. T. Garver,
Huntington, Tennessee.

AN AUXILIARY LISTENING-IN KINK

THE cover of your March, 1925, issue, certainly expresses my sentiments, but rather than use a separate crystal set, I included it as a part of my two-tube Roberts. The only extra parts needed are a jack and a crystal detector. The diagram, Fig. 7, is self-

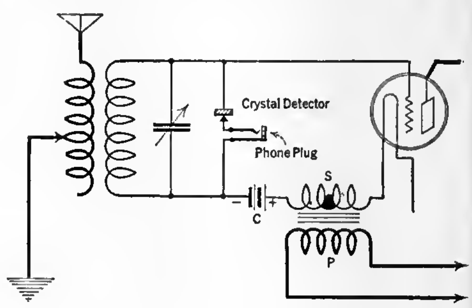

FIG. 7

explanatory, and the system may be applied to practically any circuit.

To use the crystal set, merely plug the phones in the jack and adjust crystal.

Walter Senter,
Omaha, Nebraska.

[*The cover in question shows a smiling radio fan contentedly listening-in with a crystal set and headphones while in the background is a tube set which evidently cannot be coaxed to function. Presumably our correspondent intends to switch in the crystal set when the batteries run down, or in other emergencies.*—The Editor.]

AS ANNOUNCED in this department every month, a prize of twenty-five dollars is awarded to the person who submits what is adjudged to be the best idea during each three-month period. The award for the period just concluded goes to Mr. John L. Lee, of Washington, District of Columbia, whose idea, "How to Make Balloon Coils," was printed in the March Radio Broadcast.

THE BEST IN CURRENT RADIO PERIODICALS

The Seventh Installment of a Useful Classified Survey of Material Appearing in the Radio Press

By E. G. SHALKHAUSER

How This Survey Can Help You

HOW often have you looked for information contained in some article which you recall having read months ago—the description of the Browning-Drake receiver, or the measurement of losses in inductance coils, for example? After looking through probably several issues of a dozen different publications, you either give up or become interested in something altogether different.

When data is wanted on some particular subject, a systematic file of subjects and titles becomes a real radio encyclopedia. Instead of having merely the title of an article given, which often is misleading, a summary of the contents gives all the information. These surveys cover the radio field as gleaned from material in to-day's periodicals. They will always serve as a future reference-guide to all who are interested in the science of radio, whether engineer, manufacturer, dealer, experimenter, or listener.

To be of practical value and easily accessible, these surveys should either be pasted in a scrap book, or, better still, be pasted on individual cards and filed according to numbers, or alphabetically. In the matter of classification of articles, the Bureau of Standards circular No. 138 has been followed. This may be obtained from the Government Printing Office, Washington, District of Columbia, for ten cents. In addition, each abstract has certain key-words placed at the upper right, which may be used for the purpose of filing articles alphabetically.

With this series of surveys we hope to aid our readers and help them through many difficulties which they no doubt have often experienced. The writer is prepared to give information and references to articles previously surveyed upon receipt of a stamped and self-addressed envelope.

Following is the series of headings, made up according to the Dewey Decimal System used in the Bureau of Standards circular No. 138:

R000 RADIO COMMUNICATION IN GENERAL.
Under this heading will appear all subject matter pertaining to laws, regulations, history, publications, etc., which deal with radio in a general way.

R100 PRINCIPLES UNDERLYING RADIO COMMUNICATION.
Here will be given the phenomena of radio waves, their underlying theory of propagation, the principle of antenna and counterpoise, design and characteristics of vacuum tubes and their behavior in circuits, types of circuits, transmitting and receiving apparatus and their principles of operation.

R200 RADIO MEASUREMENTS AND STANDARDIZATION METHODS.
The various known methods which have been used in measuring frequency, wavelength, resonance, capacity, inductance, resistance current, voltage, dielectric constants, and properties of materials, will be mentioned here.

R300 RADIO APPARATUS AND EQUIPMENT.
A description of various types of antennas and their properties, the use of the electron tube in various types of receiving and transmitting sets, other methods of transmission of signals, various detecting devices used in reception, instruments, and parts of circuits, come under this heading.

R400 RADIO COMMUNICATION SYSTEMS.
The spark, modulated wave and continuous wave systems in transmission, beat and other methods of reception, wired wireless, automatic printing, the buzzerphone and Fullerphone, will be given here.

R500 APPLICATIONS OF RADIO.
To aviation, navigation, commerce, military, private, and broadcasting, and the specific information under their headings, are referred to here.

R600 RADIO STATIONS.
The operation, equipment, and management of radio installations, both transmitting and receiving, the testing, the rules and regulations concerning stations, the reports and bulletins issued will follow under this heading.

R700 RADIO MANUFACTURING.
Data relative to costs and contracts of radio equipment from raw material to finished product, including factories, tools, equipment, management, sales and advertising, follows here.

R800 NON-RADIO SUBJECTS.
The matter of patents in general; the mathematics and physics, including chemistry, geology, and geography; meters of various kinds; all information not strictly pertaining to radio but correlated to this subject, will be found under this heading.

R900 MISCELLANEOUS MATERIAL.

A Key to Recent Radio Articles

R343. ELECTRON TUBE RECEIVING SETS. RECEIVER. *Browning-Drake*
Radia News, Feb. 1926, pp. 1142ff.
"The Browning-Drake Regenaformer," V. D. Hurd.
The Browning-Drake receiver depends for its sensitivity upon the maximum transfer of energy through one r. f stage to the other, the capacity coupling between primary and secondary being relatively small compared to the coefficient of coupling, which is made large through a unique slot winding. With most other r. f. transformers used as couplers and designed to give an amplification factor of about eight, a factor of only about three or less is actually obtained, says the writer. The transformer described is said to have an efficiency of better than 90 per cent. The outline here presented includes the theory of the receiver and constructional data on a four-tube set of the writer's own design.

R384.1. WAVEMETERS. WAVEMETER, *Calibration of.*
Papular Radio. Feb. 1926, pp. 181-182.
"Calibrating an Oscillating Wavemeter," S. G. Taylor.
Use is made of the standard frequencies sent out by station WWV, of the Bureau of Standards, Washington, District Columbia twice each month, in calibrating a wavemeter. Method of procedure during an actual test evening is related, using four coils of different sizes and an oscillating receiver to cover a definite waveband.

R134.4. REGENERATIVE ACTION. REGENERATION, *Multiple.*
RADIO BROADCAST. March 1926, pp. 563-567.
"What Multiple Regeneration Can Do for Your Tuned R. F. Amplifier," V. D. Landon.
The basic principles of multiple regeneration in receiving sets, and the application of this control system to existing receivers, is outlined. In the circuits shown, the Roberts, the Browning-Drake, and the neutrodyne, an extra tube with a tickler coil or other regenerative system gives greater selectivity and volume to the receiver. Facts about the operation of the circuit are given.

R200. RADIO MEASUREMENTS AND STANDARDIZATION. STANDAROS OF L, R, C.
RADIO BROADCAST. March 1926, pp. 573-576.
"Standards for the Home Laboratory," Keith Henney.
This third of a series of articles for the home laboratory discusses measurements of inductance, resistance, and capacity. With standards for making measurements which may be obtained at a nominal cost from several companies here listed, the constructor may build and compare intelligently any of the variables entering into a radio circuit. Equations of inductance, capacity, and resistance, are given, including several bridge arrangements for measuring unknown values.

You can use any combination of tubes in the same set with the

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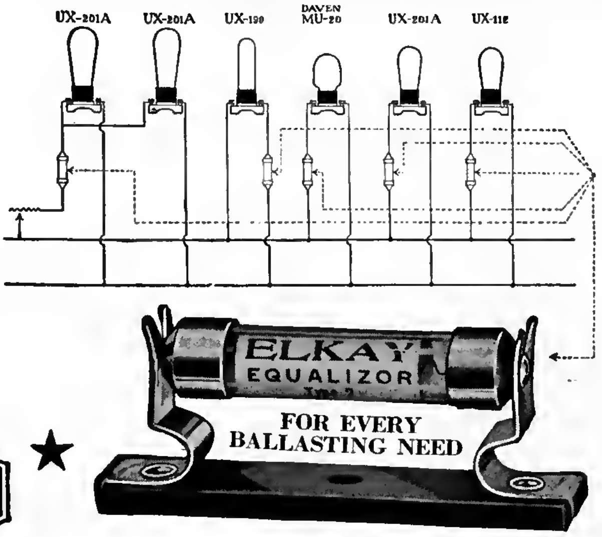

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R132. Amplifying Action. Distortion in
Popular Radio. Feb. 1926, pp. 112-123. Amplification.
"How to Reduce Distortion in Amplification,"
H. S. Knowles.

In a preliminary discussion dealing with distortion in audio amplifiers, the author refers to the inter-electrode capacities and resistances found in vacuum tubes. The information covers: 1. The relation of grid voltage to grid current; 2. The determination of grid potential to prevent distortion; 3. A discussion of a series of curves, static and dynamic, showing effect of resistance in the plate circuit; 4. A theoretical and actual determination of amplification per stage (with examples worked out for illustration purposes); 5. A determination of the relation of B Battery voltage to amplification constant of the tube (the mu value); 6. A discussion on the correct capacity for coupling condensers between stages, and the value of leak resistance in connection with the capacity. In the appendix, the author makes reference to information of a similar nature found in other books and publications.

R250. Current Measurement. B Battery
Popular Radio. Feb. 1926, pp. 134-141. Current.
"How to Cut Down Your B Battery Bill," E. H. Felix

B Battery current used in most receiving sets may be reduced in several ways without loss in volume and usually with an increase in selectivity. Three methods of doing this are mentioned and discussed; 1. By the use of C battery or utilization of drop across the rheostat; 2. Employment of lower plate voltages; 3. Regulation of filament current. The method to use depends upon the circuit, the power to be handled by the tubes, and the number of tubes used, according to the writer. Detailed references are made to several typical circuits, such as the super-heterodyne and neutrodyne. A summary application of the principles discussed is given in conclusion.

R343. Electron Tube Receiving Sets. Receiver,
Popular Radio. Feb. 1926, pp. 142-155 *Orthophase.*
"How to Build the New Orthophase Radio Receiver,"
R. J. Griffith.

A four-tube receiver, the "Orthophase", embodying a new radio frequency amplifying principle, is presented. Crystal detection is used with apparently good results. Quality of tone and selectivity are said to be characteristics of the receiver. One stage of transformer-coupled and one resistance-coupled amplifier constitute the audio circuit. A detailed account of the features of this receiving circuit is given. Constructional details are complete, including photographs and diagrams, panel drillings, and list of parts.

R110. Radio Waves. Radio Waves,
Popular Radio. Feb. 1926, pp. 165-167. *Theory of.*
"Rolling Hoops Through the Ether."

The two outstanding theories of ether waves, the ether wave theory and the quantum theory, are compared. Here Sir Oliver Lodge discusses the possibility of both theories being in part correct, and suggests a possible hoop form of ether waves, which are pictured in a diagram.

R710. Factories. Factory,
Radio News. Feb. 1926, pp. 1110-1111. *Atwater-Kent.*
"Radio Receivers By Production Methods," J. A. Pern.

A trip through the Atwater-Kent daylight factory reveals the magnitude of present-day radio manufacturing, as told by the author. Views are shown depicting the departments devoted to construction and assembly of parts. The immense machinery used in shaping the steel for the loud speaker bells, and the extreme precision required of other machines, is spoken of. Each set is inspected many times before final delivery.

R110. Radio Waves. Radio Waves.
Radio News. Feb. 1926, pp. 1126-1127.
"More About Radio Waves," J. Riley.

A further discussion on the principles of radio waves (continued from the January issue), is given. Included are details covering electric and magnetic fields and their relation to each other. Graphic illustrations help in bringing out the points under consideration. Doctor Fleming's explanation of these two fields is given, and the writer states that much experimentel work must be done in order to verify the statements made.

R344.3 Electron Tube Generators; Transmitter,
Transmitting Sets.
Radio News. Feb. 1926, pp. 1128-1129. *Crystal Control.*
"Calibrating Receivers with Crystals," J. L. Reynolds.

The application of a quartz crystal oscillator in calibrating receiving sets, is outlined. From the diagram presented, the writer shows how various definite frequencies can be fed into a common antenna wire which in turn is connected to the receiver under test. Trap circuits prevent all but the desired frequency from entering the receiver. The method of mounting the crystal and cabinet used for the entire layout, is pictured.

R113. Transmission Phenomena. Transmission.
Radio News. Feb. 1926, pp. 1139 ff. Phenomena.
"Facts and Fallacies of Radio Wave Transmission,"
Dr. J. H. Dellinger.

Prevailing ideas and theories concerning wave propagation on low and high frequencies are discussed by the Chief of the Radio Laboratory of the Bureau of Standards. The Heaviside-Kennelly layer theory, the Larmor theory, and the experiments by H. W. Nichols and J. C. Shelleng on fading, may all lead to some definite conclusion on the real nature of radio wave transmission. At present we are far from a definite solution, says the writer.

R343.5. Heterodyne Sets. Super-Heterodyne
Details.
Radio Broadcast. March 1926, pp. 589-592.
"Super-Heterodyne Construction," H. C. Weber.

The writer discusses the various component parts of the super-heterodyne in turn. The function of the first detector tube is important, regeneration and proper high frequency bypass condenser being necessary for best results. The oscillator coils must be correctly built, a good tube and comparatively low plate voltage being necessary in this unit. Concerning the intermediate-frequency amplifiers, the writer mentions the respective advantages of air, and iron-core transformers, preference being given to the latter. Data on an air-core transformer for tuned input and output circuits are given. The second detector tube should have a comparatively low value of grid leak.

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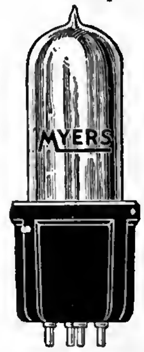

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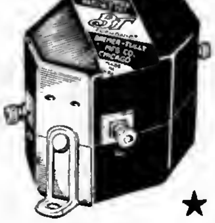

J. E. Owen, Bureau of Tests and Measurements University of Oklahoma and Radio Digest Technical wr ter says, "I find your apparatus very excellent indeed. To my mind there is no better audio transformer buy on the market than your 2.2 to 1 ratio EUPHONIC at anything near the price."

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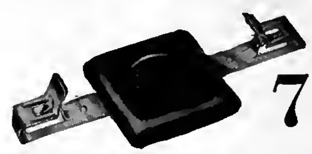

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R388. CATHODE RAY OSCILLOGRAPH. OSCILLOGRAPH, *Radio News*. Feb. 1926, pp. 1132 ff. *Cathode Ray.* "Special Cathode Ray Oscillographs," C. B. Bazzoni.
The cold and hot cathode ray oscillograph tube is discussed as to its practicability in analyzing high frequency currents. In the cold cathode tube, voltages of 10,000 or more are needed to produce an electron stream. A 110-volt a. c. rectifier circuit to supply this voltage, is shown. Due to the very great speed of the oscillations in a high frequency circuit, it is impossible to see the line traced on the fluorescent screen unless the end of the beam retraces its exact path many times. Substituting a photographic plate means considerable complications in the operation of the tube, since it must be inside the tube. The French scientist, Dufour, designed the oscillograph here described, with film and screen within a hollow chamber attached to the tube, and with provision for exhaustion while the tube is in operation. The author discusses the functioning of this tube. The hot cathode tube oscillograph is also discussed and shown, it being more sensitive than the cold cathode tube according to the writer, because the velocity of the electrons is much less at the applied voltage of about 400. Other uses can be made of this tube, some of them being listed.

R160. RECEIVING APPARATUS. TESTING THE *Radio*. Feb. 1926, pp. 22ff. RECEIVER.
"How to Test Radio Receivers," H. Diamond.
A circuit used for testing the relative performances of radio receiving sets consists of a radio frequency oscillator and modulator, an audio frequency oscillator, and an indicating device to determine the magnitude of the received signal in the set under test. The circuit diagram is shown. The following tests can be made: Measuring distortion; obtaining variation of signal strength with wavelength; and determining selectivity. The method of operating the equipment is described. A typical curve shows the variation of signal strength with wavelength.

R113.5. METEOROLOGICAL WEATHER AND PHENOMENA. RADIO CONDITIONS.
RADIO BROADCAST. March 1926. pp. 558-562.
"Can We Forecast Radio Reception From the Weather," J. C. Jensen.
Evidence is presented to prove some definite relationships between weather conditions and radio reception. The general conclusions arrived at by the writer may be summarized as follows: 1. Signal strength will be greatest with settled weather conditions and transmission parallel with lhe isobars; 2. Good reception may also occur at right angles to the isobars unless a storm center intervenes between sending and receiving stations; 3. Static is most noticeable as a storm area approaches, the crashing noises being audible for several hundred miles, and the hissing noises prevailing only in the immediate vicinity of a "low"; 4. Fading is much less troublesome in daylight than at night; 5. Fading is much more noticeable in unsettled weather than when transmission is parallel with the isobars along the ridge of a "high". Charts and curves are presented to substantiate the above statements.

R113.9. WAVE FRONT ANGLE. WAVE PROPAGATION.
QST. Feb. 1926, pp. 9-17.
"Horizontal Reception," R. S. Kruse.
Measurements made by Dr. G. W. Pickard on horizontal and vertical field intensities of waves in the 3.5-4 and 7-8 megacycle band (80 and 40 meter bands), show that the wave after traveling some 20 to 30 miles, becomes horizontal, the vertical component giving a relatively small intensity when compared with the horizontal component. The author presents the fundamental theory of electro-magnetic and static fields and the operation of the original Hertz oscillator. He gives data on the ratio of horizontal to vertical intensities of the short waves, collected from a great many observations made during the summer of 1925. The earth's magnetic field apparently had no effect on the measurements as stated. The horizontal type antenna, as pictured and described, is recommended for short-wave reception. Other types of antennas tried, and circuits used, are also shown, with remarks as to their effectiveness in these particular tests.

R343. ELECTRON TUBE RECEIVING SETS. RECEIVER, *QST*. Feb. 1926, pp. 18-22. *Short-Wave.* "Short-Wave, Plug-in-Coil, Receiver Design," F. J. Marko.
A short-wave regenerative receiver of the plug-in-coil type, is described in detail. Three coils are used to cover the three bands commonly used by the amateur stations at present, although the coils have overlapping wavelength curves when used with the condensers specified. The coils are wound on skeleton frame forms thus reducing the dielectric losses. The operation of the receiver and detailed analysis of the various parts that govern good reception, such as proper grid leak and condenser values, r. f. chokes, size of wire, antenna characteristics, etc., are described. Three calibration curves of the receiver show location of stations on the dial settings.

R343.7. ALTERNATING CURRENT SUPPLY. ELIMINATORS, *QST*. Feb. 1926, pp. 23-32. *B Battery.* "Battery Substitutes," R. S. Kruse.
B battery substitutes may be more economical, more convenient, or give superior performance than dry or wet batteries, according to the author. Using five different types and makes of receivers, many B battery eliminators were tested. The results are given here. Circuit diagrams and photographs of these eliminators tested, are shown, and information is presented concerning the particular behavior and operating characteristics of each.

R386. FILTERS. FILTERS.
QST. Feb. 1926, pp. 35-36.
"Filtering the Synchronous Rectifier," Chauncy Hoover.
A brief description of a filtering problem encountered in connection with a synchronous rectifier, is presented. Several arrangements of condensers and coils were tried by the writer and are shown in the diagrams. The finally adopted system was chosen since it gave very good filtered direct current when measured with an oscillograph.

R343. ELECTRON TUBE RECEIVING SET. RECEIVER, *Radio*. Feb. 1926, pp. 15ff. *Non-oscillating.* "A Non-Oscillating R. F. Circuit," Charles H. Smith.
A five-tube tuned r.f. receiver, using split wound coils to reduce interstage coupling, and high resistance wire for the primary, is illustrated and described. Constructional details, and method of operating the set, are outlined.

R545. AMATEUR RADIO. AMATEUR RADIO, *Experiences in.*
RADIO BROADCAST. March 1926, pp. 547-551.
"A Man and His Hobby," E. E. Horine.
The ever interesting and fascinating hobby of the "ham" who constructs his own inexpensive transmitters and receivers with which he communicates to fellow amateurs everywhere on earth, his language, his philosophy, his quick adaptation to new developments in radio as they are made, are graphically portrayed by the writer in giving the story of Colonel Foster's experiences as a "ham." Photographs of several short-wave transmitters are shown.

R384.1. WAVEMETERS. WAVEMETER, *Calibration of.*
QST. Feb. 1926, pp. 39ff.
"Calibrating Your Wavemeter From a Quartz Crystal," J. M. Clayton.
A crystal oscillator circuit, shown and described, is used for purposes of calibration. While the crystal is oscillating, the frequency of the oscillations is said to remain constant, irrespective of capacity values, the watts output, however, varying. A large number of harmonics are generated, and these may be detected either using an oscillating receiver, or better, an auxiliary Hartley generator circuit with grid milliammeter indication. The method used in calibrating a wavemeter, using whole and fractional harmonics, is described in detail. Companies furnishing quartz crystals are listed.

R070. EDUCATION; TRAINING. ENGINEERING, *Radio.*
QST. Feb. 1926. pp. 44-45.
"Entering Radio Engineering," R. S. Kruse.
The writer gives his personal opinion of radio engineering as a profession. His views are shared by other engineers who are prominent in radio, as stated. A general engineering course supplemented by specialized study and research in high frequency phenomena, are requirements for the grade of radio engineer, according to the writer.

R402. SHORT-WAVE SYSTEMS. SHORT-WAVE, *Eiffel Tower.*
Radio. Feb. 1926, pp. 10ff.
"The Eiffel Tower Short-Wave Transmitter," L. Jacquet.
The short-wave transmitter (3333-1874 kc. or 90-160 meters) used a. the Eiffel Tower, Paris, is described. It employs a new circuit designed after the principle of the push-pull amplifier. It is stated that parasitic oscillations, which would necessitate the use of choke coils, are not encountered, thus making the circuit very stable when in operation. A schematic circuit diagram, and photographs of the station, are shown.

R592. DEVELOPMENTS IN GREAT BRITAIN. BROADCASTING. IN ENGLAND.
Radio. Feb. 1926, pp. 11ff.
"Broadcasting in The British Isles," H. de A. Donisthorpe.
A list of high and low powered broadcasting and relay stations of the British Isles, including locality, call letters, wavelength, is given. The system employed in England in operating these stations for the benefit of the public, is described. A map is given showing the distribution of these stations.

R342.5. POWER AMPLIFIER. POWER AMPLIFIER.
Radio. Feb. 1926 pp. 17ff.
"A High Quality Power Amplifier," H. W. Armstrong.
In the author's opinion, there is room for improvement in the audio stages of most amplifiers when the question of distortionless amplification is considered. A two-stage amplifier, utilizing choke coil and resistance coupling, with rectified a.c. as a source of power for the plates, is shown. The first stage employs a high-mu tube, the second a power tube which feeds the output energy to the loud speaker through a transformer. A complete list of parts necessary for construction is added. When connected to any good receiver, distortionless amplification with considerable increase in volume is promised by the author.

R333. ELECTRON TUBES. THREE ELECTRODE. ELECTRON TUBES, *Transmitting.*
Radio. Feb. 1926, pp. 19-21.
"Transmitting Tubes," Lieut. J. B. Dow.
General Electric and Western Electric transmitting tubes of various sizes and output values, are depicted. The G. E. tubes normally employ thoriated filaments, whereas the W. E. tubes have oxide coated platinum filaments. The W. E. tubes are more critical as to filament temperature and therefore not as safe because of release of gases within the tube at the higher temperatures; but they have a longer life, when properly burned, than the thoriated filament tubes, according to the writer. Grid-plate characteristics of several of the tubes, and data of most of the transmitting tubes manufactured by these two companies, are given. Several G. E. kenetron rectifier tubes and data covering these, is also included in the article.

R134.75. SUPER-HETERODYNE ACTION. SUPER-HETERODYNE.
Radio. Feb. 1926, pp. 29-31.
"Super-Heterodyne Suggestions," L. W. Hatry.
The super-heterodyne, although only six of the tubes are actually used in the eight-tube variety for amplification purposes, is superior to a six-tube tuned r.f. receiver, because it is more selective, more stable, and easier to operate, states the author. A large loop is recommended as an energy collector rather than a small one. Questions regarding regeneration, addition of intermediate-frequency transformers, proper bypass condenser values, proper use of the energy from the oscillator tube, shielding of the set to prevent undesired pick-ups, etc., are discussed at length.

R113. TRANSMISSION PHENOMENA. POLARIZED WAVES.
Radio. Feb. 1926, pp. 34ff.
"Polarization of Radio Waves," E. F. W. Alexanderson.
Tests on three types of radiators to explore the propagation characteristics at different wavelengths of radio waves, have been in progress at the General Electric Company's experimental plant. The three types of radiators are—1. The straight vertical antenna oscillating at a harmonic frequency; 2. The horizontal antenna with an overall dimension of one-half wave fed in the middle through a transmission line; 3. The series and horizontal loop. The radiation from these antennas is projected at a high angle. From the data obtained through an extended series of tests, it appears that horizontally polarized radiation is superior to vertical radiation. With the aid of a unique laboratory model, which the writer describes, the theory of wave propagation, vertical, horizontal, and eliptical, may be shown. A difference in velocity of these waves probably causes many hitherto unexplained phenomena.

BOOK REVIEW

A Book for Both Radio Enthusiast and Engineer

TALKS ABOUT RADIO. *By Sir Oliver Lodge. Published by Hodder & Stoughton, in London; in New York by George H. Doran and Company. 259 pages. $2.50.*

HAVE you ever visited a huge industrial plant, accompanied by a well informed and interesting guide? At one point, the guide goes into considerable detail about a particular operation in the plant which seems to interest him especially. Other parts of the factory are hurriedly skipped over through lack of time. But altogether, a two-hour visit is very interesting and profitable.

Sir Oliver Lodge's treatment of the subject of radio in his recent book, *Talks About Radio*, is in somewhat the same manner. Here and there, Sir Oliver makes clear as crystal certain phases of radio communication which most writers neglect, and he neglects those things which most writers treat in detail.

The spirit in which the book is written is indicated in the writers preface which states: "This is a friendly rather than an ambitious book. It is a message of greeting to the great army of wireless amateurs and experimenters, from one who—always enthusiastic about ether waves—did some pioneering work; and who now admires the remarkable progress that has been made by others. May they all take it as conveying the author's good wishes, combined with a hope that, in the diversity of these gossipy chapters, each may find something acceptable, something worthy, of his or her interest."

The publisher's statement, appearing on the paper cover, to the effect that "Sir Oliver Lodge puts at the command of the amateur and professional alike all the benefits of his study and research in the science of the air," seems quite inaccurate and exaggerated. We doubt whether all the salient points of Sir Oliver Lodge's vast knowledge of radio are presented in the book's 259 pages of text, and we question the accuracy of the statement that the book deals with the science of the air.

The book is divided into three parts, each consisting of about ten chapters. The first part deals with radio in general, the general phenomenon involved in the propagation of electromagnetic waves, radio's early history, and with the contribution of physicists and scientists whose work is appreciated by only a few, and deplorably forgotten by the many. Sir Oliver Lodge reveals himself as much philosopher as scientist. His text is steeped with appreciation of the social significance as well as the scientific importance of the radio art. He deals frankly with his contemporaries, as indicated by the following quotation:

"Before 1896, the public knew nothing of its (radio's) possibilities; and for some time after 1896, in spite of the eloquence of Sir William Preece and the demonstrations by Signor Marconi, the public thought it mysterious and almost incredible; and still knew nothing about the early stages. Indeed, I scarcely suppose that Signor Marconi himself really knew very much about them."

Maintaining aloofness from considerations of circuit design, the second section of the book, under the title, "Details that Make for Efficiency," discusses with a clearness of presentation the factors of capacity and inductance, the proportioning of coils, phase differences in coupled circuits, and the use of iron in transformers. The studiousness with which constructional details are avoided is indicated by the fact that there are only three illustrations in this section of the book.

The third section deals with calculations for amateur constructors. For a mind accustomed to reasoning with mathematics as its foundation, this section is a real pleasure. Lodge has the happy faculty of carrying the imagination along with his figures so that the significance of each formula, and how it is derived, is conveyed to the reader. To the non-mathematical mind, the section would have at least greater interest than the usual mathematical treatment because his conclusions are frequently crystallized in such basic expressions as "A remarkably simple expression for the inductance of a coil so as to give that inductance a maximum value for a given length of wire . . . is . . . that it equals the length of wire employed multiplied by three times the number of turns" and, "We can estimate the capacity of an antenna by eye. Expressed as a length, the capacity of a vertical wire is just about one-twentieth of the height of the wire."

Obviously Sir Oliver Lodge is speaking down to his audience when he reaches a conclusion of this kind, but, in each case, he follows up with much greater accuracy and detail, presenting all the essential calculation for efficient coil sizes, antenna capacity, and damping in oscillatory circuits.

Throughout these pleasant excursions into the radio art, Sir Oliver Lodge clothes his thoughts in a delightful, unadorned, and crystal-clear style of writing. We believe he accomplishes his objective in creating a friendly and familiar contact, but, beyond this, it is doubtful just exactly what his general purpose is. No radio enthusiast can read the book without profiting, and no engineer will fail to find sections which express his understanding of one point or another more aptly than he has seen it expressed before. On the other hand, if you attack the book with a more definite objective, it is quite possible that you will be unsatisfied.

Edgar H. Felix.

CUBA'S SUGAR-MILL BROADCASTER

BROADCASTING station 7 SR of Elia, Cuba, transmits test programs every Tuesday and Thursday evenings at 8:30 P. M., Eastern Standard Time, according to a letter received by Radio Broadcast from Salvador C. Rionda, the licensee of the station. The power used by the Cuban station is 500 watts, and request has been made by the owners that listeners who hear this station write and inform the engineers whether it interferes with the transmissions of any American broadcaster, which, of course, is contrary to the wishes of all concerned. The Cuban Government has authorized transmissions from 7 SR to take place on a frequency between 833 and 1500 kilocycles (200 to 360 meters). At the time of writing, the frequency decided upon was between 1000 and 1034 kilocycles (290 and 300 meters). This station is located at Central Elia, Elia, Cuba, in a sugar mill that produces 75,000 tons of sugar a year; "In a sugar mill," as Salvador C. Rionda puts it, "that is at present helping the consumers in the United States in receiving cheap sugar, notwithstanding the duty of $1\frac{6}{10}$ cents per pound that is paid to your Government for every pound of Cuban sugar entering the United States."

By referring to the list of Cuban broadcasting stations in Radio Broadcast's booklet of foreign broadcasting stations in the February number of the magazine, it will be seen that very few employ as much power as does 7 SR. The majority in fact, employ considerably less than 100 watts.

CANADIAN STATIONS USE THESE WAVE-LENGTHS

THE following list of frequency bands employed by the Dominion Government is compiled from a list recently printed in a report of the Radio Division of the Department of Marine and Fisheries. It includes those bands used for broadcasting purposes in addition to those employed for ship work, commercial purposes, etc.

AMATEUR EXPERIMENTAL AND EXPERIMENTAL—

	METERS	KILOCYCLES
C. W. . .	4.69 to 5.35	64,000 to 56,000
" . .	18.7 to 21.4	16,000 to 14,000
" . .	37.5 to 42.8	8000 to 7000
" . .	75.0 to 85.7	4000 to 3500
(c)	120 —	2500 —
I.C.W. and Phone .	150 to 200	2000 to 1500
	170 to 180	1,750 to 1,665

(c) For Trans-Canada Amateur Relay Work Only.

BROADCASTING—

METERS	KILOCYCLES
200 to 545	1500 to 550

SHIP SERVICES—

	METERS	KILOCYCLES
Phone . . .	200	1500
Other . . . (Includes Radio Direction Finding, Radio Beacons)	600 to 1,200	500 to 250
. . . .	2100 to 2800	142 to 107

COMMERCIAL—

	METERS	KILOCYCLES
Beam work .	21.2 to 103.3	14,000 to 2850
Point-to-point work . .	940 to 1900	319 to 158
Point-to-point, long range and trans-atlantic work .	2850 to 3400	105 to 88
	4000 to 25,000	75 to 12

To show the activity of the direction service carried on by the Dominion of Canada, the above mentioned report tells us that the number of radio compass bearings given during the year 1923-24 was as follows:

STATION	BEARINGS
Chebucto Head, Nova Scotia . .	2875
Canso, Nova Scotia	2923
Yarmouth, Nova Scotia	1804
St. Paul Island, Nova Scotia . . .	1547
Cape Race, Newfoundland . . .	4101
St. John, New Brunswick . . .	1145
Pachena Point, British Columbia .	3050
TOTAL	17,445

Our own Naval Communication Service furnished during the past year 137,592 compass bearings to 64,497 vessels.

WHAT OUR READERS WRITE

Arthur Burrows on the International Tests

ALTHOUGH our thoughts are probably more inclined toward the next International Radio Broadcast Tests than to those of last January, we feel sure that this letter warrants publication in these columns so long after the conclusion of the Tests. The series of local tests Mr. Burrows refers to in the early part of his letter are those which have been conducted to find some plan whereby interference may be mitigated in the European ether. There are now well over a hundred broadcasters in Europe with about half as many separate wavelength channels, most of the stations being in the western half of the continent, and interference by heterodyning, etc., is causing much trouble. Possibly some system will have been put into operation to improve the chaotic condition on some wave bands by the time these remarks appear.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Many thanks for the advance proof of the article for the April issue of RADIO BROADCAST and for your kind remarks regarding our efforts on this side. We did all within our power to make the tests successful particularly as our European stations had already committed themselves to a series of local tests.

In future tests, the American organizers may rely upon our hearty collaboration, provided there is evidence that all concerned will take the matter seriously. In other words, we are keen in helping forward all organized effort to widen broadcasting knowledge, but we have no time for mere stunts.

My own personal view is that the greatest factor of all, in the relative failure of this year's tests, is the multiplication of freak sets in which distant reception, irrespective of quality, is the sole object. Many of these sets are not only a public nuisance by reason of the distressing howls which they radiate, but, collectively, screen their localities against favorable reception by the radiation of inaudible frequencies.

I am not a radio mathematician and, therefore, these personal comments should be treated with reserve, but I do know definitely how much easier it is to receive distant European stations which are transmitting specially for test purposes at hours when the possessors of radiating receivers are in bed.

I employ no reaction (regeneration) for our work here.

Very truly yours,
A. R. BURROWS,
Director,
Office International de Radiophonie,
Geneva.

Radio and the Weather

MR. JENSEN'S article entitled "Can We Forecast Radio Reception from the Weather," in the March RADIO BROADCAST, was the cause of considerable comment all over the country. Many prominent newspapers reprinted much of Mr. Jensen's material so interesting was it considered. Professor Eugene Van Cleef, who is well-known to Radio Broadcast readers by virtue of his contributions to this magazine, disagrees with Mr. Jensen on one point. Here is his letter.

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York.

Sir:

I was very much interested in Mr. Jensen's article in the March Radio Broadcast. With some of his points I am in accord, but in his opposition to my theory relative to right-angled crossing of isobars versus strong reception, I am inclined to believe that he is misinterpreting weather maps. It will not be possible for me to run a series of observations at once to show the validity of my assertions, but I may be able, through the coöperation of the Storm-O-Guide Club, to carry the matter further.

Very truly yours,
Eugene Van Cleef.
Worcester, Massachusetts.

Radio in Canadian Hospitals

THE first hospital to be fitted up with radio as a result of the drive in Toronto to provide for such equipment, is the Christie Street Hospital in that city. Considerable impetus was given to the drive by the special appeals of Roxy on behalf of the Disabled Soldiers' Fund during the recent visit of himself and his Gang up there. This letter gives some interesting details of the Christie Street equipment.

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York.

Sir:

Thinking that readers of Radio Broadcast will be interested in the installation here, I submit the following particulars. The master receiving sets are of Westinghouse manufacture, and are located in the basement. Jack boxes are located at the head of each bed in the hospital wards, and these are so wired as to give the patient the choice of a local or out of town broadcast. In all, there are 350 sets of head phones, and the equipment is valued at $7,000.

The fund has reached $12,000 to date, and subscriptions are still coming in. The amount aimed at is $30,000. The Mowat Sanitarium at Kingston, Ontario; the Byron Sanitarium at London, Ontario, and the Hamilton Sanitarium at Hamilton, Ontario, are next to be equipped. After that, it is the intention to supply every shut-in veteran with the means of listening-in. The boys really do appreciate getting in touch with the outside world, and the concession granted by the medical supervisor permitting the radio to be operated until midnight, helps greatly to shorten some sleepless nights.

Sincerest thanks to Roxy.

Very truly yours,
H. Taylor.
Ex-Chief Petty Officer.

He Tried the Short Waves

IT APPEARS that more and more fans are tiring of being confined solely to listening to broadcast programs and are devoting more time now to code, especially on the shorter waves. This is not due to any fault of the broadcasting stations, but rather is it a credit to them. They have whetted the appetite of the really ardent fans and have converted many of them to veritable "DX Hounds." Opportunities unconfined await the fan who develops the symptoms of a DX-er on the short waves. There is no limit to the distances that may be covered with the simplest of receivers. Here is a letter from a recent convert.

Editor, RADIO BROADCAST,
Doubleday Page & Company,
Garden City, New York.

Sir:

I have been interested in radio for about two years and, after tiring of the broadcasting stations, I started listening-in to the code on the 600-800 meter band. A few weeks ago I constructed a one-tube Reinartz set to cover the 50-200 meter band. With this set and one stage of audio amplification, I have already copied six of the amateur districts (the 1st, 2nd, 3rd, 4th, 8th, and 9th; fifty-seven stations in all). At present I can read and send code at about ten words per minute and am going to try for an amateur license soon. I think that there is a great deal more fun in listening to the code on the short waves than there is in listening to broadcasting programs.

Very truly yours,
STANLEY C. ALLEN,
New Bedford, Massachusetts.

Daylight Reception

MOST fans are aware of the fact that reception at night time is much better than during the hours of daylight, and many theories of this phenomenon have been advanced. An interesting letter reached us the other day from a reader giving some particulars of daylight reception in his locality, El Dorado Springs, Missouri. The fact that he was using an eight-tube super-heterodyne accounts to a certain extent for his extraordinary good results, although he states that all stations were received with good volume on the speaker.

Editor, RADIO BROADCAST
Doubleday, Page & Company,
Garden City, New York.

SIR:

As I have been very much interested in daylight radio reception, I was pleased to see the article on this subject by Mr. Alexander Sheridan in a back issue of RADIO BROADCAST. I consider the daylight range of a receiver a true test of its quality, and if a receiver is sensitive enough to bring in the DX stations during the daylight hours, many enjoyable programs may be received when static and other troubles interfere at night. Beginning last November, and using an eight-tube super-heterodyne receiver with an outdoor antenna, I decided to divide all stations into three classes, those received in winter and summer, those in winter only, and the third group, those received only occasionally. By daylight reception I mean at a time when the sun is shining both at the sending and receiving end; at midday for example. In all cases reception was on a loud speaker and was audible in a large room. In the first group the following stations were heard—all over a hundred miles; WHO, WOAW, WOS, KSD, WOC, WHAA, WHT, WNC, KTHS, WFAA, WBAP, KFRU, KFAB, KYW, KSAC, WSB, and WHAS. In the second group, that including stations heard only during the winter months, are the following stations; WCCO, WTAS, WLS, WMAQ, WQJ, WCX, WWJ, WHA, WTAM, WOAI, WSMB, CKY, and WCBD. Included in the group of stations only received occasionally are KGO, KDKA, WEAF, CFCA, CFCN.

Yours very truly,
D. M. CRAIG,
El Dorado Springs, Missouri.

A Letter from Italy

WE ARE proud to present the new RADIO BROADCAST which, in quality of appearance and contents, speaks for itself." Thus read the opening sentence of our presentation of the first new RADIO BROADCAST, that of November, 1925. We don't like patting ourselves on the back too much, but it seems as though the magazine really has spoken for itself, judging from the many laudatory letters we have received. It has a pretty lusty voice too, and reaches out for plenty of DX.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Please accept my sincerest congratulations on the new form, and especially the new cover, you have chosen for RADIO BROADCAST. The name "Aristocrat," which you have given to the single control set described in your November number, is the name by which RADIO BROADCAST should be defined too. I have always liked your magazine in whatever form it appeared, and have constantly maintained that it was, without doubt, a straight, serious magazine. Actual conditions of exchange make it almost impossible for me to realize my great wish to be the owner of one of RADIO BROADCAST'S receivers. It is difficult for me to send for the necessary components or for a completed set, and what makes it harder is the knowledge of their absolute superiority over any we have over here. Had it not been for the fact that I am a war invalid, I should certainly have come over to see for myself and admire radio conditions in America. But this cannot be, and the only way out is by reading your first rate magazine.

Very truly yours,
CAPTAIN PESARO, M. C.,
Varese (Province of Como), Italy.

From a User of the Four-Tube Knockout

IT IS hard to choose any one letter from the great group which we have received about the Knockout four-tube receiver which has been variously described in this magazine beginning with April, 1924. The one printed below, hot from the radio fields of Nebraska, probably will interest those now using this Knockout receiver and those who have not yet constructed one too.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Just a word about your four-tube Knockout set. I read your article in the September, 1924, issue in which you mentioned the fact that a good many fans had spent large sums of money on different hook-ups without getting good results and had decided to quit radio. I happened to be in that class, and on reading your article, decided to give it just one more whirl before quitting for good.

After getting the Knockout all hooked up and working, I just felt that I owed it to you to tell you that it is the best set I ever got my fingers on. It is very selective, and has enough volume to satisfy a deaf man when you want to use it, or you can use headphones and plug in on the two tubes and adjust it just the way you want it. I have tried all the known reflex circuits in existence, but none of them has the volume on three tubes that yours has on two.

I am sure that for the money involved and the number of tubes used, you have the best hook-up yet.

C. E. B.,
York, Nebraska.

For Experimenters who prefer Impedance Coupled Amplification

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In search for a perfect amplifier experimenters are now giving much attention to coupling impedances.

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By using chokes of sufficiently high inductance, a quality of reproduction may be obtained equivalent to that produced by resistances.

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A three stage amplifier using three General Radio Type 369 coupling impedances will give a combination of generous volume with exceptional purity of tone.

Write for our circular showing wiring diagram for a 3 stage Impedance Coupled Amplifier and our latest parts catalog 924.-B.

The General Radio Company has endeavored to make it possible for the experimenter to obtain its products with a minimum of effort. A careful selection of distributors and dealers has been made. They are best fitted to serve you. If, however, you are unable to obtain our products in your particular locality, they will be delivered to you, postpaid, direct from the factory upon receipt of list price.

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Behind the Panels of Better Built Sets

RADIO BROADCAST

WILLIS K. WING, Editor

JUNE, 1926

KEITH HENNEY, Director of the Laboratory

JOHN B. BRENNAN Technical Editor

Vol. IX, No. 2

CONTENTS

BEHIND EDITORIAL SCENES

MUCH interest has been aroused on both sides of the Atlantic by the press announcements of successful transatlantic radio telephony, combined with the regular wire line system. Aside from that other startling feat—the transmission of photographs by radio, it is doubtful if any radio achievement has attracted as much recent attention, or given rise to as much speculation about the future, as has this development in the transatlantic field. One of the first questions naturally asked is, "How is it done?" Edgar Felix's article, in this number, tells just what the technical background of this remarkable telephonic achievement is.

Professor Morecroft explains in the leading article in "The March of Radio" this month just what the much-discussed crystal frequency control is, which should answer the questions of many radio experimenters. . . . On page 121, appears an article on the "Radio Broadcast Lab." Circuit, which we guarantee will provide the experimenter with some constructional ideas of an altogether different sort from those he usually finds in radio publications.

THE Listeners' Point of View this month contains the amusing and very true and keen observations of some of our best-known humorists, including the irrepressible Will Rogers. . . . Those who have had opinions without any actual facts about the "blanketing" effect of high power broadcasting stations will be interested in Howard Rhodes's article about tests made by the technical staff of RADIO BROADCAST in and around Bound Brook, New Jersey, the home of WJZ. . . . Particular attention is called to the complete list of Canadian and American broadcasting stations which is so arranged that it may be clipped out and kept for constant use in booklet form. The list is as complete and accurate as it is possible to make it. Another innovation appears in the RADIO BROADCAST Laboratory Information Sheets which, beginning with this issue, take the place of the former "Grid" department. The announcement of the expansion of the Laboratory services on page 175 should also be of great interest to our readers.

THE July RADIO BROADCAST, on sale June 15, will contain an article describing the use and construction of a combined high-quality amplifier and B current supply unit. There will also be other announcements of great interest to all those interested in short-wave work. A Radio Club of America paper, dealing with improvements in radio receivers, is also on the July schedule. Julian Aceves, research assistant to Professor Pupin of Columbia University, is author of the paper. Another article for the home laboratory experimenter, written by Keith Henney, will appear in an early number of RADIO BROADCAST and describes the use and construction of a useful heterodyne wavemeter, an instrument which is of great value around the laboratory of the home experimenter.

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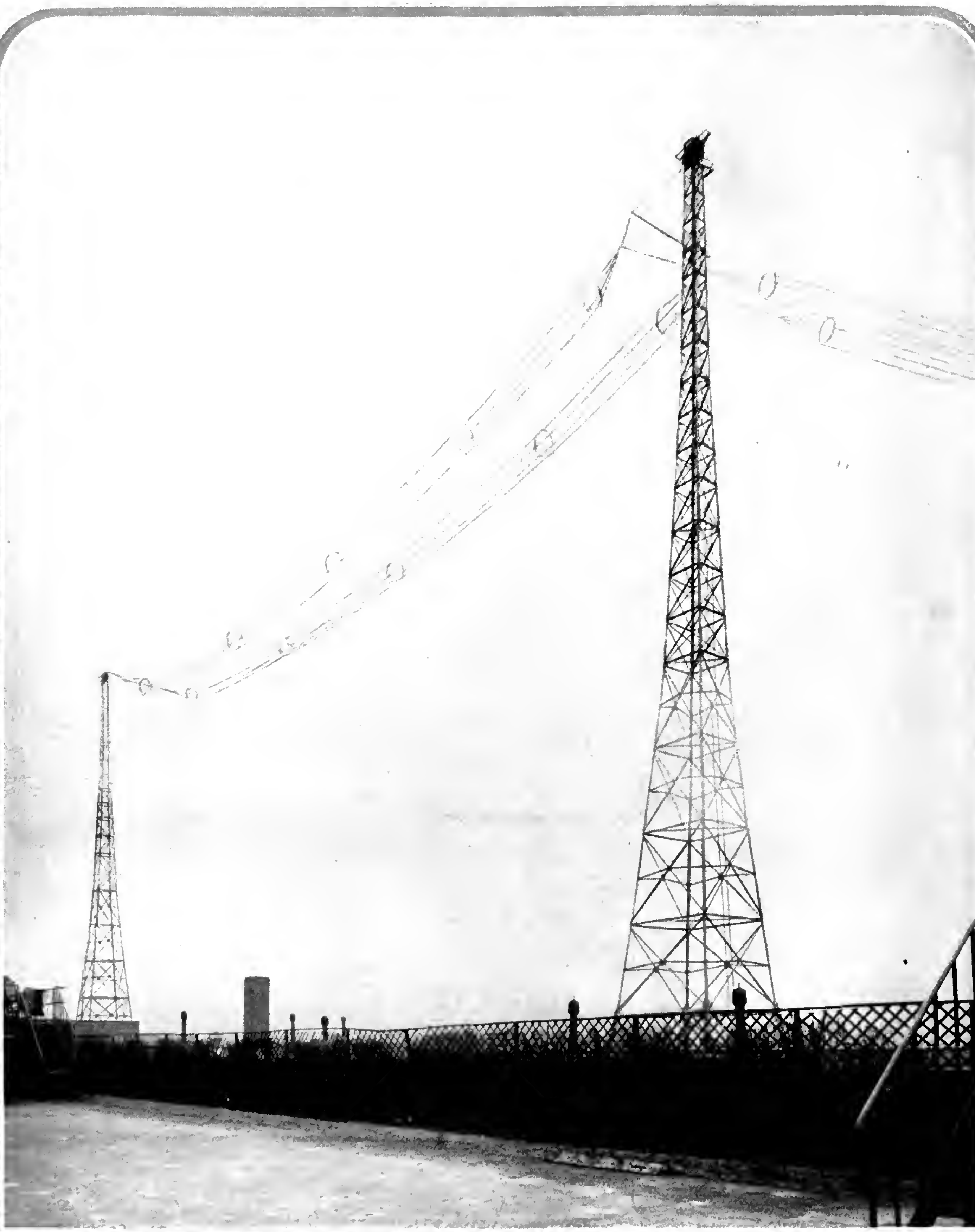


THE ANTENNA SYSTEM AT 2 LO, LONDON, THE MAIN BRITISH STATION

The "parent station" of the British Broadcasting Company system has its towers located atop Selfridge's store, Oxford Street, London. The antenna is 125 feet high. Many British listeners are content with simple crystal reception, using head phones. This station, in common with the other main stations of the system, gives a crystal range of about twenty five miles. Signals from this antenna have been received frequently in the United States and Canada, mainly during the three International Radio Broadcast Tests

RADIO BROADCAST

VOLUME IX — NUMBER 2

JUNE, 1926

How New York Talks to London

The Story of a Wonderful Radio Engineering Accomplishment Due to Many and not a Single Individual How the Principle of "Single Side Band" Transmission Made Possible Transatlantic Telephoning A New Triumph for the Vacuum Tube

By EDGAR H. FELIX

HISTORIANS have leaned heavily on Samuel Morse's "What God hath wrought," and Alexander Graham Bell's "Come here, Watson, I want you," in describing the first telegraph and the first telephone. But the recent demonstration of two-way transatlantic telephony, exactly fifty years to a day after Bell delivered his famous message to Watson, produced no significant sentence to inspire future generations of high school essayists. Instead, twenty or thirty newspaper men on this side of the Atlantic conversed with an equal number of their confreres on the other side about the weather, short skirts, and prohibition. No one utilized the opportunity to crystallize the significance of the occasion in an apt and epigrammatic phrase.

But the reason is not hard to find. The first telegraph and telephone were largely the products of a single individual's effort; their contribution, the successful solution of a problem pursued in the face of pioneer difficulties. The transatlantic telephone, on the other hand, is the product of hundreds of creative minds. No one man may point to it as his achievement, for, in the equipment installed by the America, Telephone and Telegraph Company, the Radio Corporation of America, and the British Post Office, literally thousands of inventions and processes, each contributing its part to the success of transatlantic telephony, are utilized.

It was an extraordinary radio telephone which accomplished these results, not a mere overgrown super-power broadcasting installation. A fairly new principle was applied, known as single side band transmission.

Engineers can understand exactly just how single side band transmission works, but to the layman it is simply another new phrase added to radio's growing vocabulary. Its methods are complex but what they accomplish is easy to comprehend. Only one-fourth to one-sixth the power is required to transmit a given distance; it occupies only one-half the wavelength band required by the usual broadcasting transmitter, and it is less subject to fading than the older methods of radio telephone transmission.

THE LOW-POWER UNITS

Of the Rocky Point transmitter. The speech input, modulating, filter, and amplifying panels, are depicted. The operator is regulating the volume of the incoming speech from New York by means of a potentiometer

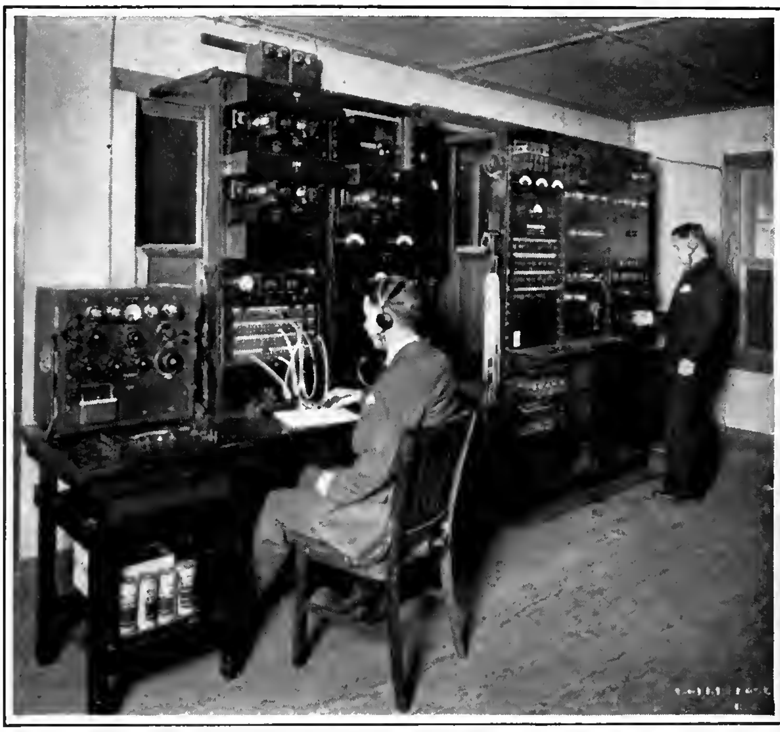
But what is single side band transmission, and how is it accomplished? You probably know that when speech or music is heard from your receiver, it is responding to a carrier wave, varied in intensity by the process of modulation, to accord with the sound waves at the broadcasting studio. The carrier wave acts as the bearer or carrier of the audiofrequency currents. But what you actually hear with your radio receiver is the result of modulation.

In your experience of fishing for long distance stations with a regenerative receiver, you have often heterodyned the carrier wave of a far-away stranger without being able to "clear up" the signal to make it intelligible. Inveterate distance enthusiasts often become dyspeptic from exasperation if frequently subjected to this experience. What they are after is modulation, not carrier. Single side band transmission accomplishes the remarkable feat of transmitting only modulation, suppressing the carrier before it reaches the transmitting antenna.

Perhaps we can make this more clear by an analogy. Suppose you have a gold coin, deeply engraved with both faces alike, which you wish to reproduce at a distant place. In order to reduce the cost of the sample coin you would naturally slice it in half, since the design on one side, being the same as that on the other, would serve as a satisfactory model. Still greater economy is affected by making the sample slice of the coin just thick enough to include the deepest part of the engraving. The indentations in the coin correspond to the variations in the carrier wave produced by modulation. As long as these variations are transmitted, we have all that is necessary.

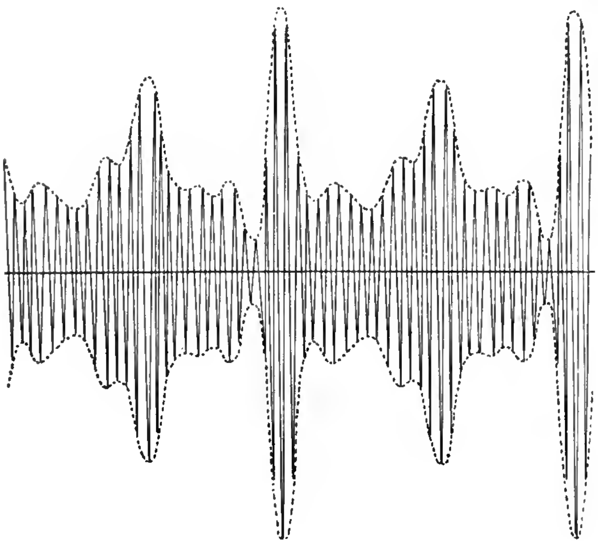
Carrying the analogy still further, to reproduce the coin at the distant place, it is necessary to restore it to its normal thickness, in order to have a coin exactly like the one of which it is a replica. This, too, is one of the requirements in the reception of single side band transmission. A local oscillator, set precisely to the suppressed carrier frequency, is necessary to restore the carrier in the receiver. This feature contributes to the secrecy attainable by the new system.

The sine curve, representing the carrier wave, is familiar to almost every broadcast listener. So is the effect of modulation upon the carrier. But observe, in the accompanying diagram, that modulation is really twice accomplished in that both the upper and lower components



THE RECEIVING EQUIPMENT IS SHOWN HERE

To the right the operator is adjusting the apparatus which is used to pick up Rugby's signals, while the gentleman sitting is responsible for the wire line circuit to New York. The necessary oscillator for restoring the carrier wave to the incoming single side band impulses is incorporated in the receiving equipment to the right

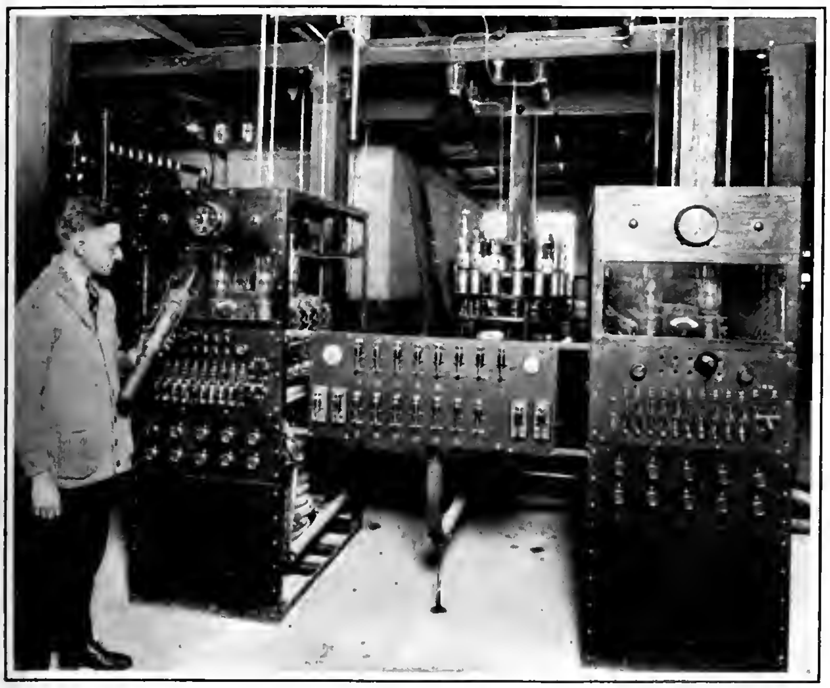


A MODULATED RADIO FREQUENCY WAVE

Would look like this if we could see it. As the author points out, modulation is really twice accomplished. Both the upper and lower components of the carrier wave are varied

THE POWER STATION AT ROCKY POINT, LONG ISLAND

In this building are housed the commercial radio telegraph transmitters in addition to the radio telephone used for the transatlantic experiments



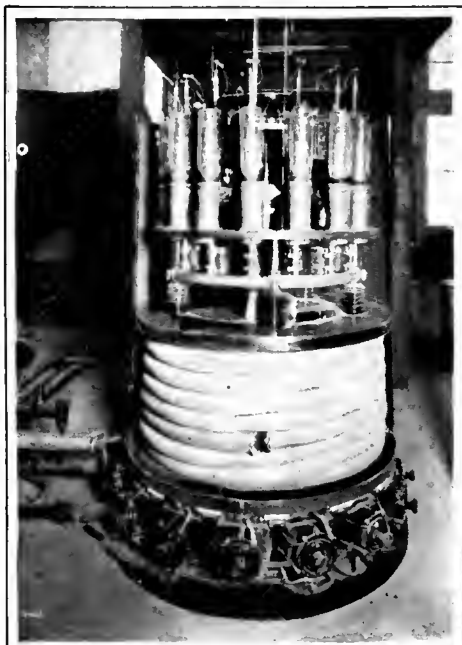
TWO AMPLIFIER UNITS

Or the high-power section of the transmitter. The ratings of the amplifiers are 15 kilowatts, and 150 kilowatts. A circular bank of water-cooled tubes may be seen in the background. The position of these amplifiers with relation to the rest of the equipment can be followed by referring to the picture diagram on page 114

of the carrier wave are varied in accordance with the speech or music. In fact, if you have a receiver which tunes with exceptional sharpness, you may have observed that there are two places on the dial, extremely close together, at which you hear a station with maximum volume. These two modulated waves are called the upper and lower side bands. In single side band transmission, only one of these side bands is radiated into the ether.

HOW THE TRANSMITTER WORKS

BRIEFLY, the transmitter works somewhat as follows: A telephone transmitter is used to secure an audio frequency current which is an electrical equivalent of the sound waves fed into it. For intelligible conversation, a frequency band from 300 to 3000 cycles in width is required. This is used to modulate the output of a low power oscillator set to 33,000 cycles a second. The output of this oscillator, when modulated by speech, has the usual two side bands, the lower from 30,000 to 32,700 cycles and the upper from 33,300 to 36,000 cycles. The next process is to pass this carrier and two side bands through a filter which suppresses the upper side band. The lower is now used to modulate the output of the second oscillator working at a much higher frequency, 88,500 cycles. When two alternating currents are combined in this way, a carrier and two side bands are again produced. The upper side band is equal to the sum of the combined frequencies (i. e. 30,000 to 32,700 plus 88,500 or 118,500 to 121,200) and the lower to their



FIFTEEN WATER-COOLED TUBES

On a circular bank, are shown above. The lower picture, to the right, shows the telephone control board in the General Post Office in Queen Victoria Street, London. It was from this point that British newspaper men recently spoke to their American brotherhood by means of the transatlantic radiophone

difference (i. e. 30,000 to 32,700 minus 88,500 or 55,800 to 58,500). The two side bands are so widely separated that they are easily filtered. The lower side band, 55,800 to 58,500 cycles, is isolated by a filter, and fed to a series of power amplifiers.

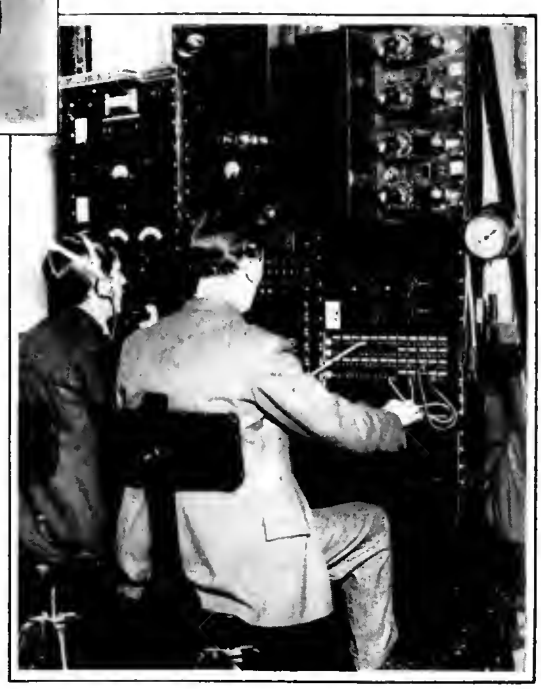
Up to this point, only feeble currents have been used to produce the single side band of the desired frequency. This desired side band having been isolated by successive modulation and filtering is now amplified by three power amplifiers, a 750-watt, a 15-kilowatt and, finally, a 150-kilowatt unit. The output of this huge amplifier energizes the antenna system at Rocky Point, and about 100 kilowatts of power is radiated into the ether. The diagram on page 114 clearly explains the operation of the transmitter.

The illustrations show the various instruments which accomplish these progressive steps. The picture on the first page shows the low-power parts of the transmitter. The two panels at the left comprise the speech input equipment, which is connected with the telephone circuit to New York. The operator is adjusting the volume by means of a potentiometer. These and the next panel include the two oscillators and filter systems which secure the desired lower side band between 55,800 and 58,500 cycles. At the right is the panel containing the low-power amplifiers, which increase the side band to the 750-watt power level.

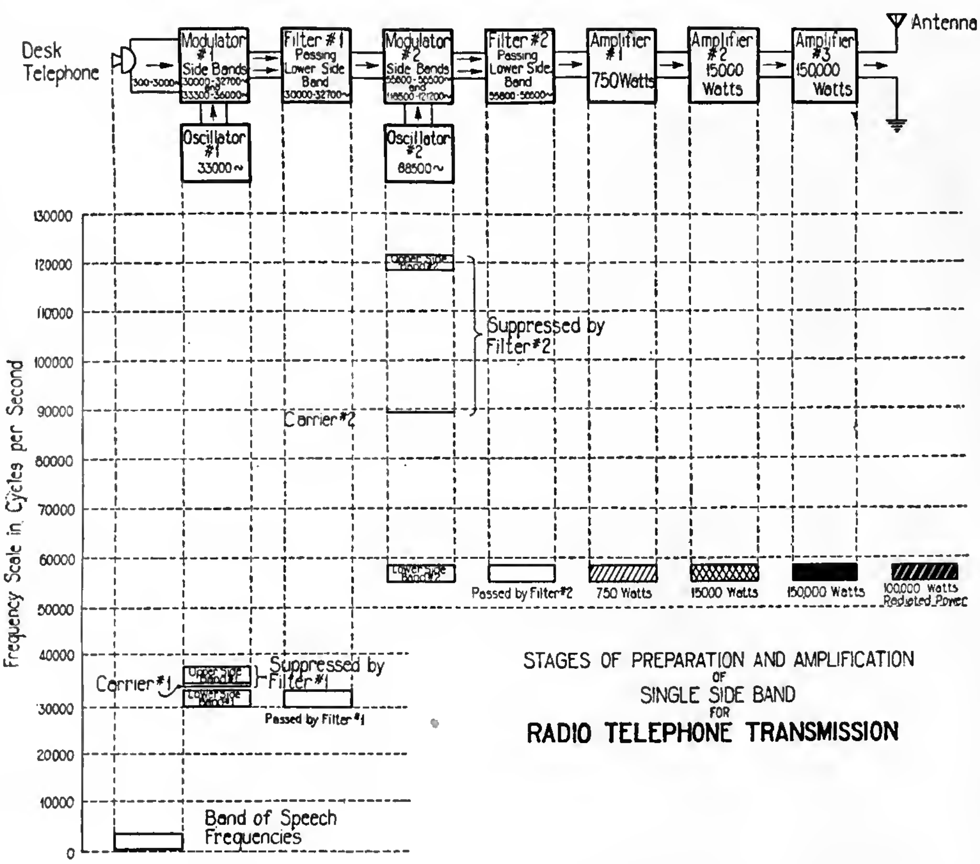
The upper picture on this page shows the 15-kilowatt and the 150-kilowatt amplifiers. The many fuses provide protection to the filament circuits. Above the fuses are a series of plugs, through which the plate current of each tube may be measured. The panel shown in the center of the picture switches in timing and recording mechanisms by means of which the hours each transmitter tube is used is automatically recorded. A close up view of a bank of 15 water-cooled power amplifier tubes is shown in the middle picture on this page. Note the elaborate water-cooling arrangement necessary to dissipate the heat generated by the tubes.

THE WATER-COOLED TUBES

ALMOST as essential to transatlantic telephony as the development of single side band transmission, are the high power water-cooled tubes. In the accompanying picture of one of these



tubes, half of the plate has been cut away in order to reveal the rugged filament, which draws 750 watts, and also the grid controlling the electrons which flow to the plate. The plate serves as the outside of the tube. This element cannot be sealed within a glass tube, as is done with smaller tubes, because glass would melt under the high temperatures generated by these huge power tubes. The lower half of the tube is immersed in water circulated by a pump. Those parts of the tube showing through the glass are the supports for the elements, and conducting terminals for the grid and filament connections. A considerable length of hose is required to insulate the plates of the tubes which are (the plates are, of course, electrically connected to the water jackets) at from 6000 to 10,000 volts above ground potential. The plate potential is secured through high-voltage transformers and rectified by two-element water-cooled tubes. Perhaps the most difficult problem which had to be met in the design of these tubes was a method of sealing the copper plate to the glass in order to maintain the vacuum within the tubes throughout the range of temperatures encountered.



HOW THE SINGLE SIDE BAND SYSTEM WORKS

Is clearly shown in this picture diagram. By reference to the amplifier part of the diagram, it will be seen that the output power of the Rocky Point station is considerably greater than that of any comparatively simple broadcasting station

THE RECEIVING APPARATUS

IN ONE of the accompanying photographs may be seen the receiving apparatus, a highly efficient yet altogether unconventional unit. The amplification equipment necessary to convey the received matter to New York by wire line, is also shown in this illustration. The three units at the right comprise the radio receiving equipment, including the necessary oscillator which restores the carrier wave. The two panels at the left include the line amplifiers and the switchboard by which the correct line to New York is selected for conveying the received signal, and the necessary service wires for intercommunication purposes. At the far left is the testing equipment for the wire line circuit to permit undisturbed speech between the receiving point in Maine and in New York. The B batteries shown are used to secure an unfluctuating voltage for test purposes, should it be required.

Considering that ten kilowatt broadcasting stations are frequently heard in Europe, it may seem surprising that 150 kilowatts of single side band transmission are required for transoceanic telephony, especially considering that the new method of transmission is four to six times as efficient as the old. But there are vast differences between occasional freak reception and the requirements of reliable commercial communication. The signal strength is very closely dependent upon the amount of light and darkness over the course which the signals follow. Unlike a copper wire conductor carrying an electric current, the medium through which radio waves are transmitted varies greatly in efficiency under different conditions.

During the winter, when the least variation is encountered, the average minimum signal strength required for good reception across the Atlantic is six micro-volts per meter, and runs up to 150, a ratio of about 25 to 1. The variation of disturbing noise, even in winter, follows as wide a ratio. Fortunately, the noise level falls during the day, when the signal volume also falls, and this factor serves to enhance the possibilities of reliable transmission. Magnetic disturbances still further aggravate the variabilities of the ether medium. With so many conditions contributing to the vagaries of the ether, it becomes easier to see why relatively immense power is required to accomplish reliable transatlantic telephone trransmission.

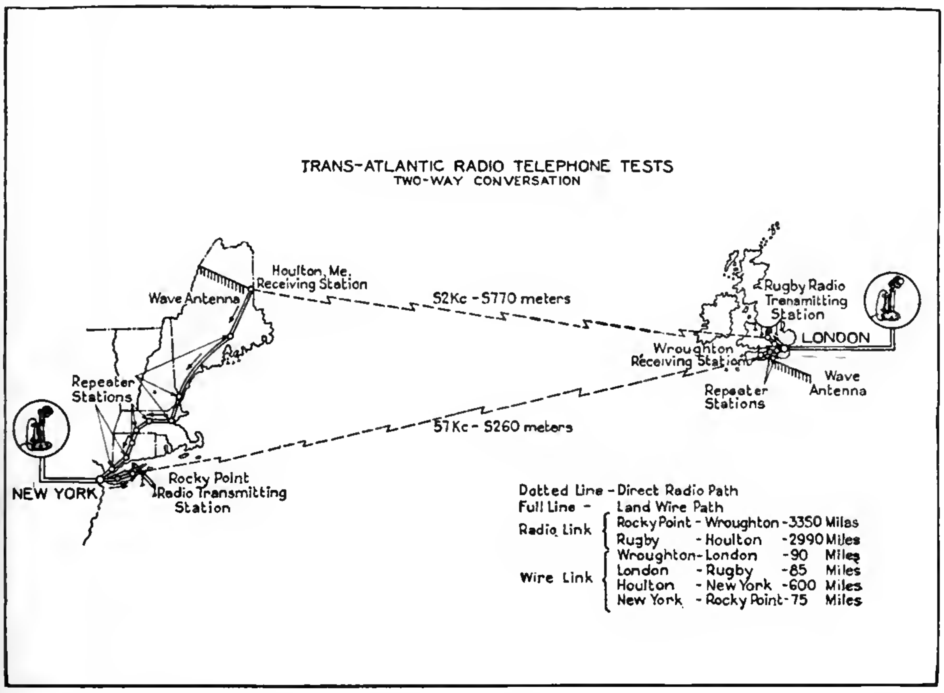
An indication of the difficulties of the problem to be met is given by the varying power requirements to obtain an equally loud signal under all conditions. Night time transmission in winter requires but little power—a few kilowatts. When it is sunrise in England and still night over here, much greater power is necessary. When heavy summer static prevails, a tremendous power increase over that required under the best winter conditions, is necessary. The engineers who have been carefully measuring signal strength at all hours and seasons estimate that 10,000 times as much power is needed to force a signal of the same volume and quality when the worst conditions prevail, as compared with that required under the most favorable.

Nevertheless, the single side band transmitter already installed has maintained a fair degree of reliability even under the relatively poor conditions. The proof is graphically shown in the percentage of test words understood in England as transmitted by Rocky Point during March, 1924. Between midnight and noon, the percentage is generally better than 95, but during the afternoon, when the sunset effect begins to manifest itself, there is a marked falling off in intelligibility.

One might suppose that this falling off in strength during the afternoon would be so pronounced in the summer afternoons as to decrease the value of the transatlantic service almost to nil. However, even during the experimental essays of these tests, on the worst afternoons, it has been possible to understand enough of the words to supply by implication those missed. Two-way communication has the advantage that repetition may be requested in an emergency.

COMMERCIALIZATION UNLIKELY YET

ALTHOUGH the recent experiments have been highly successful, telephone officials are unwilling to make definite predictions as to the likelihood of regular commercial transatlantic telephony, when,



A BIRD'S-EYE GLIMPSE OF THE ROUTE FOLLOWED BY THE RADIO WAVES

As they hurtle from Rocky Point to England. Note the frequent repeater stations which are necessary to boost up the telephone conversations as they travel the wire lines. The main receiving stations, both in England and America, are some distance from the transmitters, but wire connecting lines enable persons at both Rugby and Rocky Point to listen-in to the conversations coming from across the Atlantic

to speak to someone in Europe, you need merely call the long distance operator and give her the usual information. It must be born in mind that the tests were conducted by engineers who have devoted several years to the design and maintenance of the experimental single side band transmitter. To be commercially practical it must be within the province and ability of commercial personnel to maintain and operate the complex equipment.

For ordinary messages of greeting, the apparatus of to-day is adequate, when conditions are favorable, but the commercial possibilities of transatlantic telephony will not be fully realized until the system is perfected to a degree that it can be used without flaw for business, news, and official conversations. This requires an adequate degree of secrecy, adding still further complications. Means have already been developed, however, for attaining the same degree of secrecy in radio transmission as is possible for wire communication. Undoubtedly, this work can be successfully applied in single side band transmission.

It is idle to speculate upon the possibilities of better human understanding which will follow widespread international telephone communication. Political divisions have grown larger in direct proportion to improvements in communication. Tribes cemented into nations when roads were built and when ships began to travel the seas. The telegraph and telephone has expanded nations to the size of continents. Perhaps the new influence of the radio telephone will play a vital part in cementing nations all over the earth into a single harmonious whole. The least that may be said is that international telephony will help to better mutual understanding; mutual understanding means more tolerant adjustment of differences, and that, in the last analysis, means greater stability and more enduring peace.

THE NUCLEUS

Of the whole transmitter consists of the water-cooled tubes, an example of which is here shown. The plate element has been cut away to show the grid and filament which, ordinarily, are hidden from view

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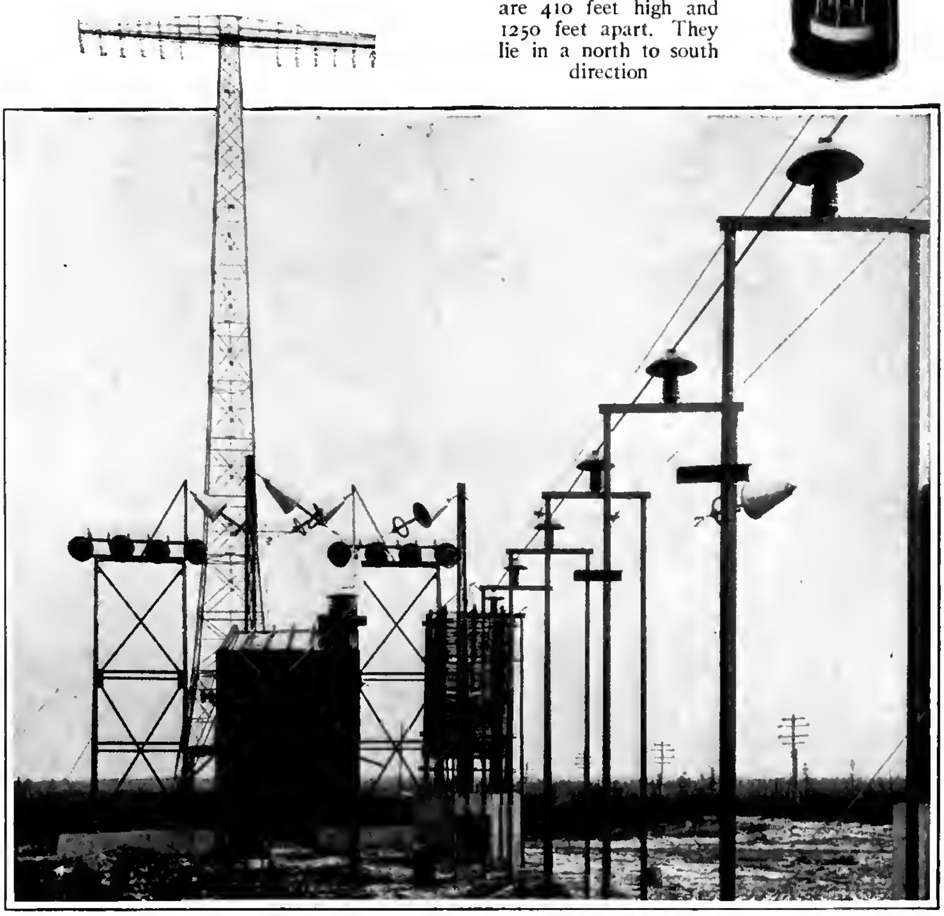


A CLOSE-UP OF THE ANTENNA SYSTEM

Six towers, one of which is shown below, support a six-wire system. The towers at Rocky Point are 410 feet high and 1250 feet apart. They lie in a north to south direction

THE MARCH OF RADIO

By J. H. Morecroft
Past President, Institute of Radio Engineers

How Crystal Frequency Control Works

WE HAVE seen and heard much lately about frequency control of a radio station by means of crystals, but apparently the statements and descriptions have been such that no simple idea of the principle involved has been made.

The two possible crystals to use for this purpose are Rochelle Salt and quartz. The peculiar property which these crystals possess has to do with their change of shape when put into an electric field, such as that which exists between the plates of a condenser in an operating radio set. There are others of the so-called piezo-electric crystals, but they show the effect to a minor degree only. Quartz is really the only one available because Rochelle Salt is so fragile.

Imagine then a small plate of quartz which has been properly cut from a quartz crystal. If tinfoil is pasted on the two faces of the slab and these two pieces of tinfoil are connected to a B battery, the slab may lengthen and become correspondingly thinner. The amount of lengthening is extremely small; it can be disclosed only by the most accurate measurement. If the B battery is connected with the tinfoil plates in the opposite sense, that is, battery terminals are interchanged, the slab will shorten (where previously it lengthened) and correspondingly grow thicker.

The reverse of this process is also true. If the slab of quartz is stretched lengthwise, its tinfoil plates, now connected to a sensitive voltmeter instead of to the B battery, show that a charge has been developed on them; the voltmeter deflects by an amount proportional to the stretch of the slab. If the slab is compressed lengthwise, the voltmeter again shows the development of a charge, but it is now in the reverse sense, that is, the voltmeter may deflect backward.

From what has been said, it is seen that if an alternating voltage is applied to the tinfoil plates, the quartz slab will alternately lengthen and shorten with the same frequency as that with which the voltage alternates. Furthermore, this lengthening and shortening of the slab will of itself generate an alternating voltage on the tinfoil plates.

Now, a small quartz slab acts just the same toward vibrations as a large metallic rod, such as a street car rail. Imagine one of these is suspended in the air by a couple of stirrups; if it is struck on the end with a hammer it will give out a characteristic tone, the same tone every time it is struck. This is called the characteristic vibration, or natural longitudinal vibration, of the rail. It will vary with the length of the rail, being a higher note the shorter the rail.

There are other modes of vibration for the rail, some of them pretty complicated. In the case of a small slab of quartz, there are two principal natural vibrations, that fixed by the length of the slab and that fixed by its thickness. The natural vibration rate (longitudinal) for a slab two inches long, one inch wide and an eighth of an inch thick is about 50,000 vibrations per second; if the slab is only one inch long, the natural vibration is about 100,000 per second. The vibration fixed by the thickness of the quartz is generally much higher than that fixed by its length.

The frequency of the natural vibrations of one of these pieces of quartz is remarkably constant. Quartz seems to show no fatigue, as do the metals, after vibrating a long time; neither has change of temperature much effect on this frequency of vibration. In fact it seems as though the natural frequency of a piece of piezo-electric quartz may be one of our fundamental physical standards at some future date.

There are two or three ways of making

The photograph heading shows the antenna, masts and station house of the Berlin broadcasting station at Witzleben. The tall tower is 135 meters high and the other 80. A duplicate station has already been erected at Munich. Cables connect the station with the studio in the city.

one of these pieces of quartz serve as a frequency standard for a radio station. The simplest connection uses the quartz in the grid circuit of a small tube, there being a suitable coil in the plate circuit. Between the grid and filament connection there is a small condenser-like arrangement, say such as would be made by using two nickels held about one sixteenth of an inch apart. Between the two nickels a small quartz slab is placed, and when proper filament current and plate voltage are applied to the tube, it oscillates at a frequency fixed by the natural mechanical vibration frequency of the quartz slab. If the piece of quartz is not a very good piece (piezo-electrically), the plate circuit, should have a condenser in parallel with its coil and the plate circuit tuned to a frequency approximately the same as the natural mechanical frequency of the quartz. The quartz, however, and not the tuned plate circuit, will fix the frequency of oscillation. The small crystal-controlled tube is used to excite a larger one which in turn may directly control the station frequency. The final power controlled may be measured in kilowatts, but the frequency of this great amount of power is being controlled, to perhaps one part in a million, by a piece of quartz about the size of a quarter.

Pending Radio Legislation

AS THE radio legislation awaits definite action by Congress we begin to wonder if the present year's activity in getting bills formulated and under way is to be as futile as was last year's. Surely Congress can see that the regulations of 1912 are insufficient to deal with the present situation and that there is a real and insistent demand for some regulation which can take care of to-day's difficulties. The Secretary of Commerce, capable as may be the present incumbent of that office, is practically helpless when confronted by an important radio question. Congress is not performing its required function if it leaves Secretary Hoover with his present severely limited power in radio matters.

Senator Dill recently gave an interview in which he expressed some interesting and some rather drastic ideas. He says:

> The question has arisen during our consideration of the bill as to whether the regulation of radio should be entrusted to the Secretary of Commerce, or to any other one man. It is my belief that at the present stage of development the details of administration should remain with the Department of Commerce, but that a non-partisan commission should be established with authority to pass finally upon questions which may be referred to it by the Secretary of Commerce or any one else. The decisions of this commission should, of course, be subject to review by the courts.

He goes on to suggest a new division of stations, according to their power into "national" and "local." He recommends that for the national stations most rigid standards be set up and that in view of the extra expense and usefulness of such stations their channels be kept completely free from interference. The local stations will in general send out material of especial interest to those in its vicinity; the amount of power required is small and as a result many such stations, in Senator Dill's opinion, could operate on the same wavelength. He confesses to no expert knowledge on the question but speaks from the point of view of an enthusiastic fan. The wave band from 1500 kc. to 1071 kc. (200 to 280 meters), he says, is at present practically useless because of the interference between the many class A stations operating within these frequency limits.

One of his suggested remedies is to put all the local stations on a very few channels; by limiting the amount of power allowed to such stations (and possibly materially decreasing the number of such stations) he feels that three or four channels should suffice for all the local stations in the country. Such a scheme certainly could not be put into successful operation to-day with the present number of such stations, as long as they use the reasonably high powers which they do.

Senator Dill then recommends that the wave band from 2000 kc. to 1500 kc. (150 to 200 meters) should be taken over for the use of these local stations. The amateurs, from whom the band would be taken, would still have their band from 100 meters down, he says. He further predicts that they would "cheerfully give up the 150 to 200 meter band to the greater service of the public as a whole." Now such a suggestion should come from a committee of technical experts, not from a legislator, and furthermore we would like to hear from the amateurs themselves rather than to take Senator Dill's prediction of their feeling in the matter.

Even should the broadcast band be extended to as high as 2000 kilocycles (150 meters), most of the receivers on the market today would be useless for receiving them.

It is interesting to observe that Senator Dill's idea regarding the division of stations into the two classes mentioned above is already working itself out. A few of the stations of the class of WEAF, WJZ, WGY, KDKA, and similar ones are rapidly becoming known among listeners as national stations whether they are so legislated or not. We certainly agree with Senator Dill that whatever change may be made in frequency allocation, the channels of these high class stations should never be encroached upon; in fact, any move to change conditions in this lower part of the frequency band should be to pull out the undesirable stations rather than add new ones.

INSTALLING AN ANTENNA IN WINNIPEG, MANITOBA
The local telephone company grants the right to use a telephone pole for $6 a year and their linemen erect the antenna for a small sum

Important Radio Patents at Present in Litigation

THERE are at present being tried in the courts, several of the important radio patents, the decisions on which may very materially affect the radio business. The Armstrong idea of regeneration, insofar as it relates to oscillating tubes, is being contested by the government in a suit in the state of Delaware. Armstrong's priority over other inventors apparently depends altogether upon a sketch of a supposedly regenerative circuit, which was accompanied by practically no explanatory disclosure. Should this sketch be proved by the government's experts to be no true disclosure of the regenerative principle, there is a possibility that the Westinghouse Company may lose one of its most valuable radio patents.

The Radio Corporation has just finished a suit in the Federal Court of Brooklyn against one of the Hazeltine licensees. The Garod Company was the defendant in the suit, but the Hazeltine Corporation undertook the defense of its licensee and Hazeltine himself served as expert for the Garod Company. The Radio Corporation based its suit on its possession of the Rice and Hartley patents, both of which it controls. They attempted to show infringement by the Garod Company.

Hazeltine showed experiments to prove to the court that the Hartley patent was practically inoperative for the circuits used in broadcast reception. After he had completed his tests, Waterman, an expert for the Radio Corporation, showed experiments to prove that it was operative. The court has the two demonstrations to consider in rendering its opinion. The decision in this case will probably be withheld until other evidence is before the court.

The Hazeltine Corporation has haled the A. H. Grebe Company into court and that case is now under way. The Grebe "Synchrophase," it is claimed, is a neutralized set which infringes the Hazeltine patents. The Grebe Company claims it does not infringe any patent at present in force.

The validity of the negative C battery and the grid leak patents is also soon to be tested out in court. The C battery patent, bought from Lowenstein by the A. T. & T. Company, and the grid leak patent, granted to Langmuir, are both controlled in the radio field by the Radio Corporation, and the Grebe Company has been selected by the R. C. A. as defendant in these suits. Another patent, that of Mathes, in which the grid is held negative by the voltage drop due to filament current flowing through a resistance, is also involved in this suit.

The above four or five patents mentioned as at present in litigation come very near to being basic patents in radio apparatus as it exists to-day.

Something About "Supersonics"

WHAT purported to be an interview with Dr. H. C. Hayes of the Naval Experimental and Research Laboratory at Bellevue, on the Potomac River, was featured a short time ago, the special achievement acclaimed being the alleged invention of the transmission of ultra-audible sound waves through water. By ultra-audible was meant sound waves so high in frequency as to be beyond the human hearing.

Some of the marvellous features of these sound waves brought two or three columns of newspaper comment. The fact that they are inaudible and to that extent secret, that they may be made to travel in straight lines instead of scattering in all directions as does ordinary sound, and many others of its remarkable characteristics were lauded as the discoveries of the Research Laboratory staff.

That is not the fact and we publish this statement of fact in fairness to those who did the work. During the war, a group of scientists, principally from Columbia University, was assigned the problem of ultra-audible sound and in the Navy files are complete accounts of all the properties now hailed as inventions of the Naval Research Laboratory.

Those scientists were sworn to secrecy by the Naval authorities on all the work they had done, otherwise the scientific journals would have received clear and authentic reports of this most fascinating branch of acoustics.

If the Naval Research Laboratory wants to make more discoveries on the action of sound of this nature (up to 200,000 vibrations a second) it would do well to consult the files of the Navy Department for the years 1917-18. The most remarkable properties of these supersonic soundbeams, as given in the reports mentioned above, have not yet been made public in so far as we know.

PART OF THE NAVAL RESEARCH LABORATORY AFLOAT

Sound barges on the Potomac, near Washington, where experiments are in progress, designed to perfect the super-sonic telephone for undersea communication. As Professor Morecroft points out, much research on super-audible sound waves was carried out by Columbia University experimenters and others, during the recent war

What About Libel by Radio?

WE ARE all of us very adverse to a censorship of radio channels—freedom of speech is one of the foundation stones of our Constitution and any measure which threatens to encroach on this feature of American liberty at once arouses our antagonism.

But a situation has now arisen which demands some analysis and action and when the probable legislation is passed we shall again be reminded that "liberty" as our radical element interprets it, isn't quite the same thing as most of us take it to be. While the Constitution grants to each of us liberty of speech and action that liberty is guaranteed in so far as the speech and action do not interfere with the rights of others. The rights of others are generally overlooked by those who insist upon complete liberty for themselves.

In our country it is a crime to write libellous matter and it is punishable by fines and imprisonment. This is as it should be. We are at liberty to write only that which does not interfere with the rights of others. The spoken word, however, is generally not a cause of action for slander—the slanderous remarks must be written. The reason for this distinction is evident when one considers how difficult it would be to prove conclusively what a man said. What a man has written, however, is there for the judge and jury to see for themselves.

How about slanderous remarks spread over the radio channels of the country? Does the injured man have no legal redress if his reputation is besmirched in the hearing of a million of his countrymen? Evidently here some new regulation is required and it looks as though it might soon be forthcoming. Representative Blanton of Texas proposed an amendment to the White Bill which makes it a crime to utter scandalous remarks over a radio channel. This, the House did not incorporate in the final form which reached the Senate. According to the Blanton amendment any person who utters a libel or scandal by radio may be prosecuted either in the state from which it was broadcast or in any state where it was received.

A court in Oklahoma City already has a case before it, an action to which the Blanton amendment would apply. Station KFJF, operated by the National Radio Company of Oklahoma City is in trouble because the pastor of a local church declared over this radio channel that Sheriff Friss had accepted a bribe not to enforce the Prohibition Law. The pastor is sued for $55,000 and the radio company for $20,000 in the libel action of the sheriff. As the law stands, the sheriff's action probably cannot be sustained, but with the proposed amendment in effect, the minister would have to prove his assertion or be adjudged liable for damages.

It has not yet been defined legally as to what extent the radio station is liable for the material sent out over its channels, but if the Blanton amendment becomes operative the law may make it a co-defendant with the scandal-dispensing speaker. This will make more necessary the precaution which most stations take at present to have their speakers read, from a written copy, whatever they have to say. Someone must have previously read over the copy and the station operator must check what actually goes out over his channels with the copy beforehand. If material departures are made by the speaker, the operator can shut off the microphone until the speaker comes back again to the material which he was supposed to send out.

Since the above was written the Oklahoma court has dismissed the Friss case, the lawyer for the defense putting up the plausible argument that the radio station was no more liable for scandal sent over its channel than was the telephone company for permitting a scandal to travel over its wires connecting the speaker's microphone to the radio station.

With the law as it exists at present, the dismissal of the suit was a foregone conclusion; courts are to see that the laws of the land are obeyed, but it is not their function to apply old laws to new and unforeseen circumstances. New regulations must be passed to meet new conditions and until they are, the radio station owner and the alleged slanderer are apparently beyond the grasp of the law.

When one considers the future and possible increase in censorship at our radio stations it becomes ever more evident that we must guard against a possible monopoly of the radio broadcast service. If the station owner is allowed to censor what shall and shall not be sent out over his channel, a combine of stations might become a dangerous factor in controlling a country's news. A monopoly of radio channels is not to be put in the same class with the wire telephone monopoly of the A. T. & T. Company. Such, we believe, functions for the direct benefit of the American public, but a broadcast monopoly would be a bird of entirely different hue.

Fees For Broadcast Music Should be Fixed

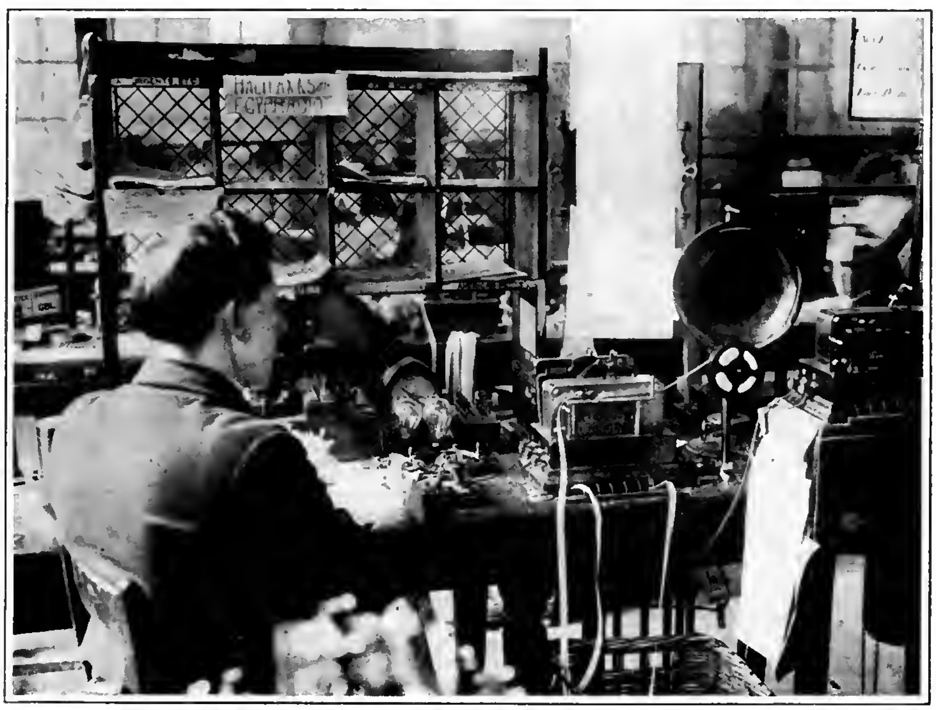
ACCORDING to the National Association of Broadcasters, some radio stations are being charged extravagant figures for the privilege of broadcasting copyrighted music. Legislation at present under consideration will compel the broadcasting station to pay a statutory fee every time a copyrighted number is sent out, but nevertheless this legislation has the support of the broadcasters' association. This support is based on the theory that whatever tax the new law provides, the broadcaster will at least know what the performance is going to cost him. The station manager needs to devote perhaps ninety per cent. of his program to music, so that music they must have. The statement of the National Broadcasters Association gives us the unexpected news that some stations are at present being charged royalties of more than $25,000 in one year!

Can the Voice be Carried on Light Beams?

ACCORDING to a news dispatch from Birmingham, Alabama, it seems as though radio waves may be somewhat affected when they travel through a beam of light. Some experimenters were manipulating a huge searchlight on the top of a high building and apparently their voices were carried to some of the radio antennas in the neighborhood. The report states that engineers of the General Electric Company are investigating the phenomenon to see if the effect is a real one and if so how it can be controlled.

There may be a real effect to be found; it has been known for a long time that an arc, such as is used in searchlights, could reproduce the human voice with a remarkable degree of fidelity. If the current from a radio receiver is passed through an arc light, which is already burning from the current supplied by a continuous-current generator, the arc will act as a very good loud speaker. (Of course precautions have to be taken not to burn up the radio set).

If then this effect is a reversible one, which seems very likely, voices in the vicinity of the arc will vary the intensity of the light beam in a manner corresponding to the sound waves. If, then, a beam of light does affect the radio waves traversing it, we could expect the voice of the arc



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A CORNER OF THE GENERAL POST OFFICE RADIO ROOM, LONDON

The photograph shows some of the automatic Wheatstone tape transmitters in use. The circuits here are London-Halifax, which is carried out on long waves via Leafield (Oxford), and Egypt. The operator is checking the signals as they leave the transmitting antenna many miles away, through the loud speaker at the right

HIRAM PERCY MAXIM

Hartford, Connecticut; President of American Radio Relay League, and of International Amateur Radio Union

(Especially written for RADIO BROADCAST)

"The broadcast listener thinks he has had a thrill when he hears the announcer of a distant station give his call letters and say what the next number of a program is to be. But it isn't any thrill at all compared to what the two-way communicating amateur enjoys when he works back and forth and holds two-way communication with the antipodes. That's the big thrill. And, that's the real office of radio. Listening is not even half of the game.

"Anybody can get into the amateur transmitting game. Learning the code is no stumbling block. On the contrary, it is an easy thing if a little help is secured. The great brotherhood of two-way communicating amateurs all over the world, is ready and anxious to help and to extend the warm hand of welcome.

"There is hardly a country in the world where there are no transmitting amateurs. In North America, we amateurs have our American Radio Relay League, and in foreign countries we have our International Amateur Radio Union. Our amateur transmitting brotherhood is organized on a world-wide basis, and is fast building up national and international friendships that are of very great value indeed."

operator to be heard in nearby radio receivers. Whether this possible effect is a real one, the engineers working at the task will soon let us know.

Increased Radio Appropriation for the Department of Commerce

IN RECOGNITION of the great increase of work loaded on the Radio Supervision Service of the government, Congress has increased the funds available for that service by about fifty per cent. over what it was last year. The budget allowed \$354,000 for this work, but this has been cut to \$335,000. Even so, it is \$115,000 more than was provided for the present year's operation. Besides opening additional sub-offices in Dallas, Memphis, Los Angeles, Pittsburgh, and half a dozen other interior cities, money is provided for three new radio test trucks. With the additional inspectors provided for, it is anticipated that much closer watch can be kept on the broadcast channels to help eliminate avoidable interference.

The Month In Radio

THE award of a medal for "conspicuous service" with a selection committee composed of well known names in the world of science and public affairs has been announced by our excellent contemporary, *Popular Radio*. Their announcement states that "it shall be awarded without discrimination to all amateurs—men, women or children, of any race, nationality, color, or creed—through whose prompt and efficient action radio is utilized to perform an essential part in rescue work. The awards shall be restricted to non-professionals only." Communications should be addressed to Dr. E. E. Free, Secretary, Committee of Awards, *Popular Radio*, 627 West 43rd Street, New York City.

AN IMPORTANT change in Navy transmitter practice has been inaugurated at the Naval Training Station, Great Lakes. The use of the thirty-kilowatt arc transmitter, will be discontinued and all the traffic will be handled by a new triode outfit, generating a frequency of 8630 kilocycles (34 meters). If the use of this high-frequency transmitter proves as reliable as is now anticipated, the arc oscillator will be permanently dismantled.

This Great Lakes station is the first of the Navy outfits to rely solely on high frequency; it has been a pioneer in this work and so really deserves the honor of showing the other Navy stations the way.

This station effected communication with the U. S. S. *Seattle* when this vessel was in Honolulu harbor last summer, and also this was the station which kept in touch with Commander MacMillan when he was on the northern end of Greenland almost a year ago. All of that official Navy traffic was handled through this station.

For the last few months daily schedules of traffic with Washington have been carried out with various frequencies. It was found that 8630 kilocycles carried equally well day or night so that was chosen as the official frequency.

Interesting Things Said Interestingly

GORDON C. SLEEPER (New York; President, Sleeper Radio Corporation): "Only a comparatively few firms, suffering from unwise overproduction, have been guilty of the practice of 'jumping' accompanied by slashing price reductions, and the sooner they pass out of existence the better for everyone concerned. Reputable companies having the interests of the radio business at heart and themselves desiring to continue in it, have not and will not tolerate price cutting, and their good work in maintaining standards will be especially evident during this year.

"Radio has by no means even approached the sales saturation point, but I feel confident that the next twelve months will see that condition nearer in sight."

W. G. CADY

Middletown, Connecticut

Professor of Physics, Wesleyan University

(Especially written for RADIO BROADCAST)

"The oscillator plays the same part in the transmitter that a pendulum does to a clock. It determines the wavelength of the station where it is used. The reason for using the crystal as the master oscillator is that it makes a very much more constant frequency possible than could be assured without it. The fading of radio signals which amateurs find so troublesome is due, in part, to the fact that the wavelength of the broadcasting station is not constant but varies slightly. The quartz oscillator entirely does away with the variability of wavelength.

"Experiments with the crystals were begun in wartime when they were used in connection with the detection of submarines. A crystal which was mounted in a suitable case was submerged, and when it was connected with an electrical source it sent out a beam of high-frequency sound which came back as an echo from any submarine which happened to be in the neighborhood. The echo was received on the same crystal that sent out the sound.

"There are various circuits for quartz crystals in connection with vacuum tubes. Some of these are oscillating circuits for transmitting stations, while others are for the purpose of using the crystals as frequency standards for calibrating wavemeters and other measurements in the radio laboratory."

MME. SCHUMANN-HEINK (New York; opera and concert singer): "When I sang over the radio in New York the other day, my son, who is one of my most intelligent and severest critics, listened-in to analyze the radio reproduction of my voice. He told me afterward that he had actually heard me breathe in singing. I was horrified, for it is an unforgivable sin for a singer to let her breathing be heard.

"Now, my breathing could not have been heard by the keenest ear of an observer sitting in the first row of the orchestra. The microphone was only a few inches from me as I sang, and it therefore caught the slightest vibration. In other words, my radio audience, hundreds or thousands of miles away, heard me as though they were standing a few inches from me as I sang. This gives radio a wonderful advantage to hear the finest shading of tones and the details of the singer's technique."

The "Radio Broadcast Lab" Circuit

New Applications for the Toroid Coil—Another Experimental Article Introducing a Circuit of High Gain, Sound Design, and Unusual Efficiency—Another Fascination for the Home Experimenter

By KEITH HENNEY

Director, Radio Broadcast Laboratory

THIS article is the first of a series which describe a circuit which has been known and used in various fragmentary forms by a number of investigators. The original circuit is probably due to Dr. L. M. Hull. Betts and others of the Western Electric Company have also contributed much. A great deal of development and research, covering many months, has been done in RADIO BROADCAST *Laboratory, and in the form in which the circuit is now presented in this series, we believe confidently that the radio constructor will find a circuit which has more to offer than any design presented to him since the introduction of* RADIO BROADCAST'S *famous Roberts circuit. For efficiency—and that term is not used idly—it will be difficult to find any home constructor's circuit which can compare with it. This article presents the experimental background of the circuit and describes several models which can be built. Later articles will show exactly how to build a number of models which are decidedly worth waiting for. We present here enough material to keep the true home experimenter busy for some time to come.*

—THE EDITOR.

TO THE average home experimenter who possesses a laboratory of sorts, there appear to be two possible directions in which his energies may be spent. Either he conducts experiments for their own sake, or he works at many small tasks, with the completed whole—a receiver, let us say—in mind.

Suppose, then, that you are such an enthusiast to whom the series of articles appearing in this magazine for home experimenters has appealed. The experiments related so far have been for their own sake, although the apparatus described has been such that many applications exist for it. Suppose that you wish to design a new receiver. In what direction will you turn?

The home experimenter, having decided that he wishes to design a new receiver, will not depart from the general rule, which is that he likes to see concrete results of his day's work. He does not wish to blunder into a blind alley. He proceeds with caution.

Radio, as he looks at it, seems to be like a blackboard upon which new ideas are written daily, and as often erased. Some of the ideas are good, few of them are new. And up in the corner of the blackboard marked "do not erase" are the tried and true schemes that have come down through the stormy days of radio. The elimination of the super-heterodyne, the tuned radio frequency amplifier, the regenerative detector is not expected. Further than that, what can one say?

The home experimenter, then, reasons that he needs a new idea, and he knows beforehand that he will not likely stumble upon something that will completely overthrow existing conditions in the radio

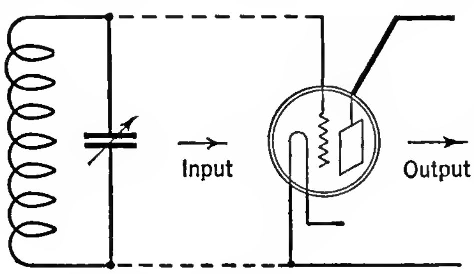


FIG. 1

The fundamental unit around which every radio receiver is built. A coil and a condenser will have considerable voltage across it when properly tuned, and this voltage when applied to the input of an amplifier will be considerably augmented. The extent of the amplification depends upon the inductance and resistance of the coil

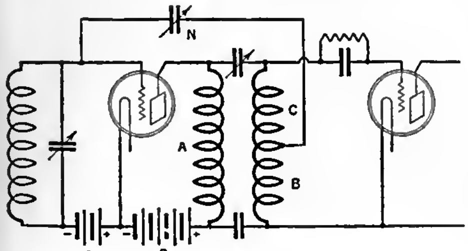
engineering field. His reasoning will probably be something like the following.

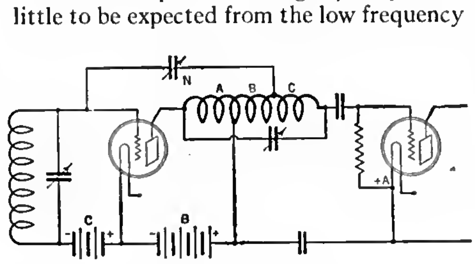
Practically all new ideas that radio schemers have are due to the desire to improve either the quality of reproduction or the selectivity and sensitivity of the radio frequency part of their receivers. Present day high quality transformers, the use of properly constructed and operated resistance amplifiers, the introduction of semi-power tubes and the general application of cone speakers of high quality leave little to be expected from the low frequency end of a set. But many people believe that the radio frequency part of receivers is a closed book.

If the home experimenter will look over the radio writings of the last few months—which is a good idea in itself—he will find considerable mention of toroid coils, and he may wonder if all the conflicting statements are correct. Probably, if he has been interested in radio for any length of time, he will know that the toroid is not a new idea, but that coils of this nature have been employed in the telephone industry for years. Its migration into the field of radio frequencies was thought of by many people—witness the fact that a good half-dozen appeared on the market practically simultaneously. And the experimenter will find that some of the articles, written evidently by people who know, state that the toroid has no business in the radio industry.

To dispute the right of the toroid coil to a place in the radio sun requires that the complainant have a clear picture of what he asks of a coil, and upon this point many people seem to have hazy ideas.

The experimenter will sit down and draw a picture of the fundamental radio circuit, a coil and a condenser with their terminals connected together. He will attach to these terminals, the grid and filament of a vacuum tube, as shown in Fig. 1. He will note that he has the input circuit of a high frequency amplifier. What he wants, then, is to find out the relation between the





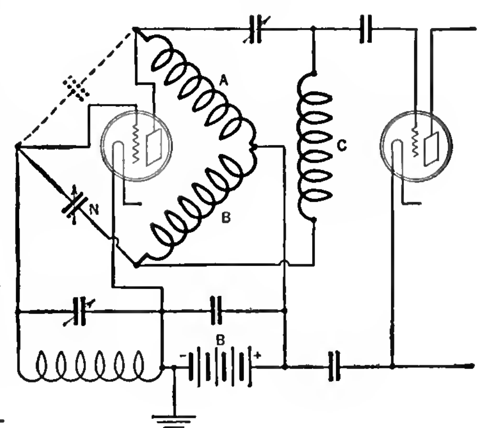
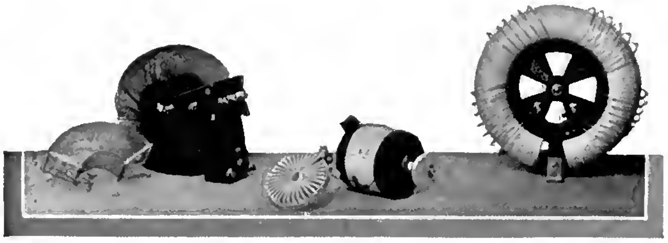


FIG. 2

These circuits are all the same, drawn differently—and depending upon the source of their popularity, their names differ too. The first is the original Hull circuit appearing in *QST*, the second is the newspaper and *Radio* version, and the third is the so-called "Bridge" circuit



RADIO BROADCAST Photograph

FIG. 3

Three methods of introducing voltages into toroid coils. One, Bremer-Tully, uses an extra coil placed inside the toroid proper, Naxon uses turns placed outside the toroid, and the Radio Foundation coils have an external coupling coil

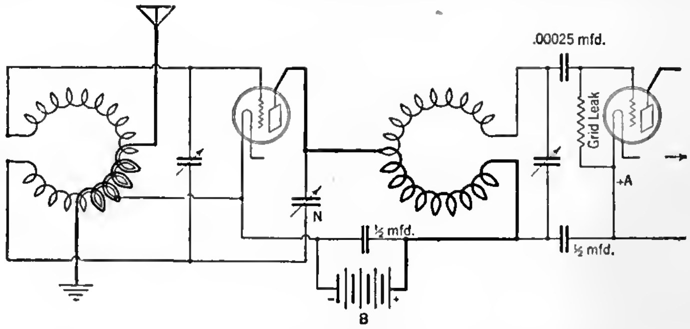


FIG. 4

A toroid receiver circuit which uses no additional coupling coils but which utilizes part of the detector coil to introduce energy into the detector circuit. A similar system was used in the RADIO BROADCAST "Universal" receiver

amplification he can get from this combination of gear and the kind of coil he uses.

THE GAIN IN R. F. AMPLIFIER COILS

FORTUNATELY the business of determining the effect of using a good or bad coil has been done for the experimenter and the work described in RADIO BROADCAST many months ago by Harry A. Diamond, in April, 1925. This nice piece of research was performed by H. T. Friis and A. G. Jensen of the Bell Technical Laboratories, and has been generally neglected by many experimenters and writers.

In this paper, the fact is demonstrated that the voltage gain of such a coil-condenser combination is a function of the inductance of the coil and the square root of the resistance of the circuit. Since most of the resistance exists in the coil, it behooves the experimenter to reduce the resistance as much as possible—but this factor is not so important as many writers would have us believe. In fact, the statement that toroid coils are less efficient than solenoids need not bother the builder of good receivers at all, for the difference in gain between a toroid coil amplifier and one using a solenoid of the lowest resistance will not be audible to the human ear.

If the experimenter is equipped, he can perform the illuminating experiments himself of determining what voltage amplification he may secure, but he may also use Friis and Jensen's formula to do the same thing. These engineers state that the maximum voltage amplification possible is as follows:

$$K \text{ max.} = \frac{\mu}{2} \times \frac{L \times 2\pi f}{\sqrt{R_p \times R}}$$

where R_p is the tube impedance
μ is the tube amplification factor
R is the resistance of the circuit
L is the inductance of the coil
f is the frequency

He should use this formula and the data below, which are for two types of coils taken from Sylvan Harris's article in *Radio News* for January.

R_p = 12,000 ohms (201-A)
μ = 8
R = 10.3 (solenoid)
= 18.8 (toroid)
f = 1000 kilocycles
L = 300 microhenries.
K (toroid) = 17
(solenoid) = 20

Thus the experimenter may see that the difference in gain between the best solenoid and the average toroid is not so great as many would like to prove, and when one couples this fact with many of the other advantages of the toroid he will see that there are few difficulties in the path of a good toroid receiver.

These difficulties, however, exist and the experimenter should not fall into the error of jamming a toroid into any existing circuit with the assumption that it will work

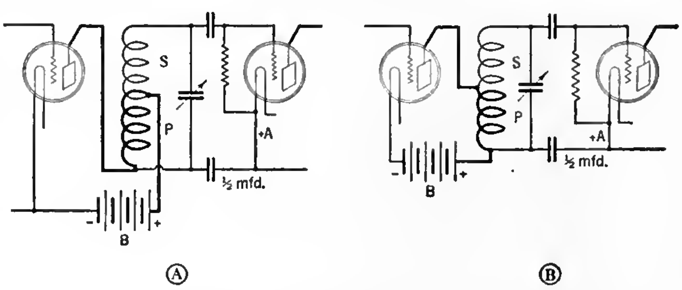


FIG. 5

These drawings show how the Hull and the "Universal" systems differ. In the Hull circuit, the plate coil has been reversed

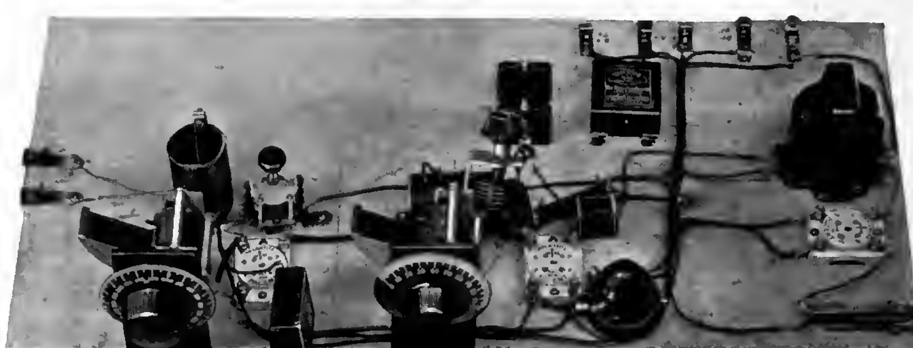
properly. It can't be done. This article and those soon to follow will show how the toroid *can* be used in a circuit whose performance is astounding.

USE AND ADVANTAGES OF THE TORIOD COIL

THE great advantage of the toroid coil lies in its restricted field. This means that energy from the coil is not likely to expand about the coil itself and interlink with other fields, and by the same token it is difficult to get energy into the coil. For this reason, a circuit in the neighborhood of powerful broadcasters is not so likely to be disturbed by local signals except those arriving at the receiver through the proper means—the antenna. The fact that the field is restricted indicates that the coils may be placed closer to metal end plates of condensers, closer to wires carrying radio frequency currents of wrong phases, and even closer to each other without the many troubles incident to inter-stage coupling.

The use of toroids makes possible the conservation of space, the maintainance of the resistance of circuits at their lowest point, the reduction of "pick-up" from external sources, the prevention of inter-stage coupling by stray electromagnetic fields, and naturally makes neutralization of high-gain amplifiers a much simpler problem. All of these things are possible, of course, provided that proper precautions are taken, and provided that the experimenter does not play with an inherently unstable or unbalanced circuit.

Now for a little history. In the January, 1924, *QST*, Dr. L. M. Hull described a circuit that promised considerable voltage amplification. It was brought to the



RADIO BROADCAST Photograph

FIG. 6

An experimental set-up of the "Bridge circuit." Coils of small diameter are recommended in order that their external field will be small attention of several radio experimenters with the result that the circuit is now variously used and variously named. It has come to the Laboratory in many guises, among them being the "Betts" circuit, the Western Electric Bridge circuit, the R. F. L. circuit, and on the Pacific coast it is probably known as the Best circuit.

Fig. 2 is a compilation of several of these circuits, including Doctor Hull's original scheme shown in *QST*. Although many have claimed credit for connecting an amplifier-detector coil as Doctor Hull has done, it is believed that he should get whatever glory there is in it. The circuits in this Figure are really all the same thing, drawn differently.

Although the Hull circuit was not originally designed for toroid coils, it has lent itself to their use with peculiar effectiveness. The chief trouble with toroids at present is that few people seem to know how to get energy into them without spoiling all of their good qualities. Fig. 3 shows several methods. The conventional inductive coupling with external coupling coil is bad since it introduces large capacity and resistance losses. Inductive coupling by means of a separate plate coil is not so good since it results in two fields, a strong one due to the tuned circuit and a weak one due to the plate circuit. Neither of these coils are complete toroids and naturally the field is not so constricted as one wishes.

In Fig. 4 is a circuit which may be used. There is but one intertube coil which is a complete toroid tapped for the plate inductance. If this system is used, the ordinary Hazeltine method of neutralization can not be used and other resources must be drawn upon.

In Fig. 5, the Hull method is contrasted with the circuit of Fig. 4. It will be noted that there is little difference between the two circuits. In the Hull method, the plate coil has been reversed. Although they look much alike, there are certain structural advantages of the second which make it worth while. In the first place, a condenser may be used to isolate the plate and grid coils as far as d. c. and low frequency a. c. are concerned. This makes it possible to light the filament of the first tube from a. c. In the second case, the Hull arrangement makes it possible to add regeneration to the detector without extra coils.

In other words, the toroid coil receiver which can most successfully be operated is a stage of radio-frequency amplification added to a regenerative detector—the heart of the "Aristocrat," the Roberts, the Browning-Drake etc. The first coil may be a loop, a solenoid, a toroid or any type of inductance, while the amplifier-detector coupling is a toroid of only one winding.

WHERE TO TAP THE COIL

THE question of greatest importance at this stage of the home experimenter's departure upon the development of a new receiver is to determine the correct place to tap the toroid coil. This problem involves a knowledge of the input impedance of the detector tube and the output impedance of the amplifier tube, the number of turns on the coil, the inductance of the coil, and the frequencies to be received.

Considerable work was done by the writer in RADIO BROADCAST Laboratory and Cruft Laboratory at Harvard to determine the proper turn ratios, and the data below is based on the empirical formula that the correct ratio between the grid and plate coils is as follows.

$$N = \sqrt{\frac{55{,}000}{R_p}}$$

where N is the turn ratio
Rp is the plate impedance

The plate impedance of various tubes with 90 volts on the plate and negative 4.5 on the grid and the turn ratio follows

Type Tube	Rp	N	
12	18,000	1.75	
199	22,400	1.57	
201-A	13,000	2.00	
112	6,000	3.00	
High-mu	30,000	1.35	@90 volts B and 1 volt C

These facts must be noted in connection with the above data. The greater the turn ratio, that is, the fewer number of turns in the plate circuit, the sharper will be the tuning, and the lower the amplification. The lower the plate impedance of the first tube, the greater will be the amplification, and naturally the greater the amplification constant of the first tube the greater amplification. Using a high-

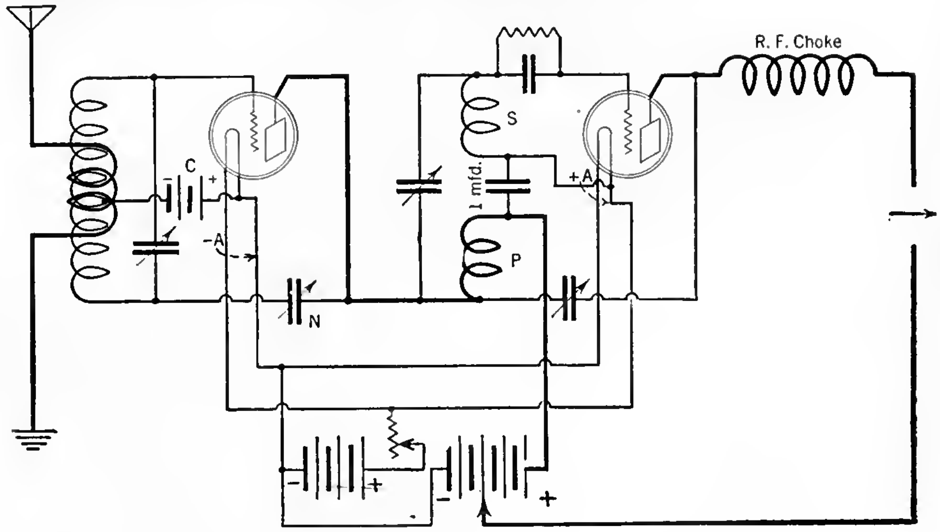
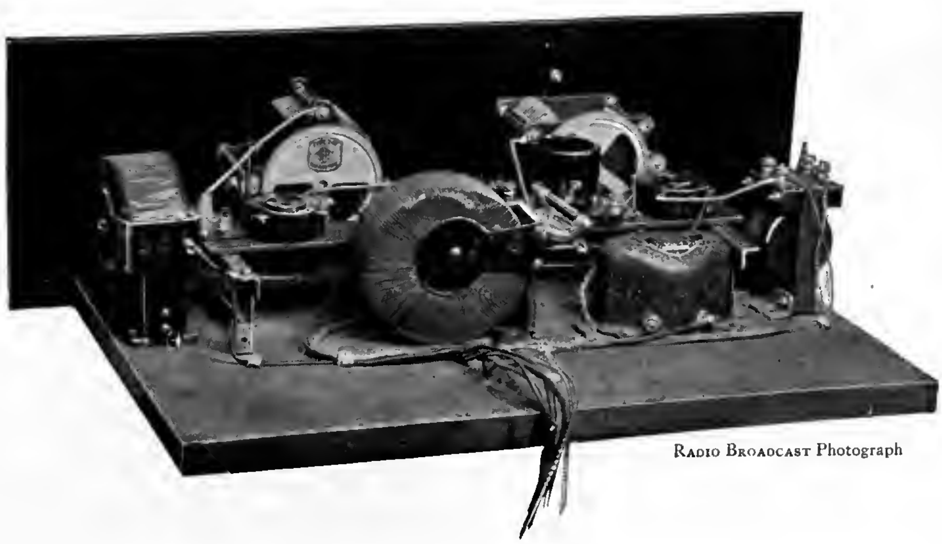


FIG. 7

The Toroid Receiver circuit containing all the modifications to bring all previous circuits up to date. This circuit employs the Rice system of neutralization, condenser feed-back to introduce regeneration into the detector, and an isolating condenser in the detector coil so that a. c. may be employed to light the amplifier filament



RADIO BROADCAST Photograph

FIG. 8

Two Bremer-Tully toroids are used in this complete receiver. The coils are "doctored" somewhat to make them suitable. The inner plate coils have been removed and the proper taps made so that connections may be made at the correct points. The choke coil for regeneration is situated directly under the detector socket and unfortunately cannot be seen in this picture. It is wound with No. 36 wire on a cotton thread spool

Important Facts Concerning the Circuit

Type of Receiver Circuit
1 stage tuned neutralized radio-frequency high gain amplifier, regenerative detector.

Audio Amplifier
Any good type of audio amplifier may be connected to the detector output.

Neutralization
Rice

Regeneration
Capacity Feedback

Circuit Origin
Hull; Bell Telephone Laboratory Engineers

Coils
Toroids, solenoids, diamond weave, etc. Any satisfactory tuner coil may be used in the antenna circuit.

Tubes
199's or 201A's satisfactory.

Parts Required
2 sockets, 2 coils, 2 tuning condensers, 1 feedback condenser, 1 neutralizing condenser, 1 filament control, 1 output jack, 1 isolating condenser, 2 choke coils, 1 grid leak and condenser.

The size of the tuning condensers employed will depend entirely upon the size of the coils used. The standard commercial coils usually take a .0005-mfd tuning condenser. The isolating condenser is 0.5-mfd and the grid condenser .00025-mfd. A 15-plate midget condenser is satisfactory for regeneration and a neutralizing condenser of the three-plate type is suitable for use in the circuit.

mu tube requires that there be practically as many turns in the plate coil as in the grid coil to get maximum amplification—which will be somewhat greater than with a low impedance tube such as 201-A—and the selectivity will suffer accordingly.

Fig. 6 is an experimental model of the "bridge" circuit built in the Radio Broadcast Laboratory to determine whether the circuit was practical or not. The diagram of connections is given in Fig. 2. It will be noted that the amplifier is neutralized by tapping into the interstage coil. This scheme represents a circuit that will work and in nearly every case it will be exceptionally sharp and with considerable sensitivity. There is the difficulty, however, that it cannot be neutralized unless everything in the circuit is placed properly and is of the correct value. The amplifier tends to oscillate until the detector is turned to it when enough energy is extracted to stop oscillations. In other words, the set tends to "lock" into the frequency that is desired and other signals have great difficulty in breaking through the two tuned circuits.

The receiver whose circuit is shown in Fig. 2 will give any home constructor many thrills. As an adventure into circuit building, it is strongly recommended. For the reader, however, who wants a set he can build with the certainty that it will work easily and surely, it cannot be recommended.

EXPERIMENTING WITH THE CIRCUIT

THE home experimenter is encouraged to try the "Bridge" circuit and then to progress to that shown in Fig. 7, the ideal form. It has all of the advantages of which toroids are capable and few of the disadvantages. Neutralization is effected by the Rice method which makes the amplifier practically independent of the detector circuit. With low loss coils, proper spacing of wires carrying radio frequency currents, and shielding if necessary, an amplifier with a large voltage gain will result.

There are many interesting points about the circuit that are worthy of discussion. Considering the detector inductance, it is seen that it consists of a coil which has been physically divided into two parts which are connected together, as far as radio frequency currents are concerned, by a large by-pass condenser. This condenser has the same position in the circuit as the

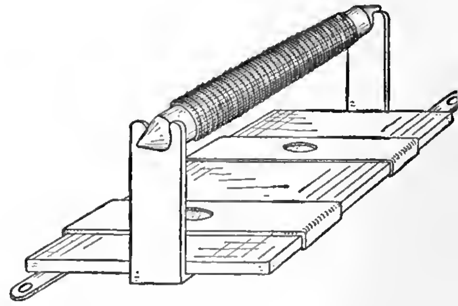


FIG. 10
One method of making a trap for the amplifier circuit. Sufficient wire is wound on the grid leak tube to tune to the offending frequency with the .00025-mfd condenser. A nail placed inside the tube broadens the tuning sufficiencly so that the number of turns is not critical

by-pass condenser across the B batteries and if all leads are short and direct and at least a 1.0-mfd condenser is across the B battery, it may not be necessary.

It is better, however, to include this condenser, which may be as small as 0.1-mfd at the coil terminals so that the coil itself is as nearly complete as possible. The tuning condenser is placed across the entire coil and only part of the voltage developed is applied to the grid. This represents a slight loss which is not noticeable, especially since regeneration is used in this circuit.

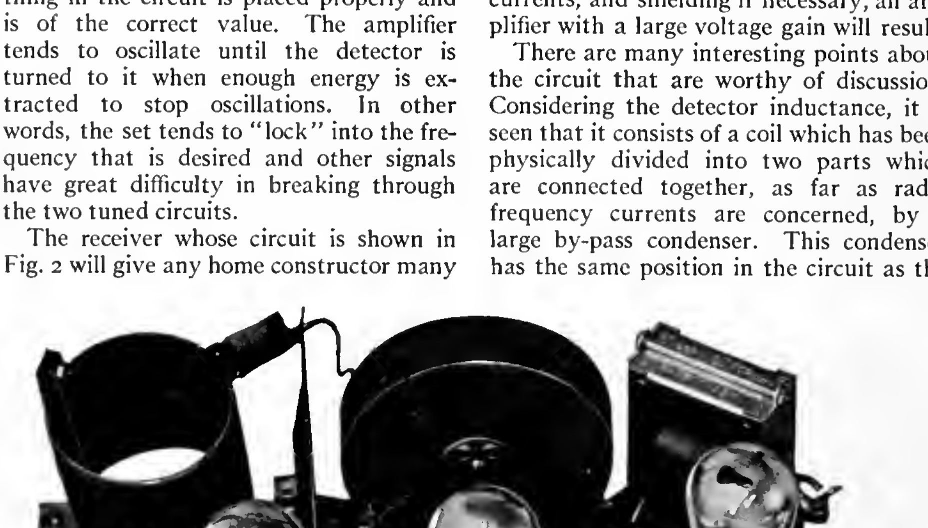
The radio frequency choke may be wound of small wire in slots in an insulating form as shown in the February Radio Broadcast on page 443 or it may be a spool on which about 400 turns of No. 32 insulated wire are wound. In the Laboratory, choke coils have been wound with the wire from an old spark coil. Coils which may be used are manufactured by the Samson Electric Company, and one is shown in Fig. 6.

The condenser connecting the plate of the detector tube with the lower end of the detector coil may be any of the small "junior" condensers now on the market. The maximum capacity depends upon the size of the choke coil and it must be large enough so that the detector will oscillate on the lowest frequency (longest wavelength) that is to be received. If the choke is very large, a smaller feed-back condenser may be used. If the choke and condenser are too small, tuning somewhere in the broadcast frequency band, erratic results will be obtained. It may cause the detector to oscillate at some frequencies and not at others, or it may be necessary to introduce more capacity to stop the detector from oscillating. Fig. 8 shows a complete receiver using two toroid coils.

Fig. 9 shows a Laboratory model of this receiver in which is used a choke coil wound of 400 turns of No. 36 enameled wire on an ordinary cotton thread spool. Regeneration is smooth and quiet in this circuit.

The wire which connects the plate of the detector to this condenser is "hot" and it must be kept away from other wires carrying radio frequency energy.

The Rice system of neutralization is employed, making the amplifier and de-



Radio Broadcast Photograph

FIG. 9
This receiver uses Samson condensers which make a compact receiver possible, an All American toroid and a Superaudioformer. It is a complete three-tube set on a baseboard 6 by 12 inches. Note the condenser which connects the two parts of the detector coil as well as the copper shield between the antenna coil and the toroid

tector circuits practically identical with regard to the placing of inductances and capacities. The center tap on the antenna inductance must be within one or two turns of the center if exact neutralization is to be attained.

The isolating condenser and the tuning condenser of the detector circuit must be well insulated, or the batteries will be shorted if the condenser shorts. The same may be said of the neutralizing condenser of the amplifier, which should be fixed at the proper point and not varied as is common on many receivers now in use.

A NEW ANALYSIS OF TROUBLE IN THE R. F. AMPLIFIER

IF LOW loss coils are used for the amplifier, a trap may be necessary in the mid-tap of the antenna secondary. The trap is necessary for stabilizing the circuit and is useful and frequently necessary in all r. f. amplifiers using Rice neutralization. If the receiver seems to be inoperative, no signals coming through, or if the amplifier seems to oscillate without regard to the neutralizing condenser, or if a plate meter shows that the first tube is taking a large plate current, this tube is probably oscillating at a very high frequency.

This frequency is usually in the neighborhood of 3748 kc. (80 meters), and is controlled by the "leakage" inductance of the coil and the capacities attached to it. What actually happens is the following. The tuning condenser is practically a short circuit for the very high frequencies. In other words, the coil is an inductance with its two ends connected together. If the coupling between the two halves of the coil were perfect, the resultant inductance when the ends were connected together would be zero. Actually, however, the coupling is not perfect, the resultant inductance is not zero, and the circuit resonates to this leakage inductance and the capacities attached to it.

A trap tuned to the oscillating frequency and placed in the mid-tap will solve the difficulty since it puts enough loss into the circuit, at that frequency, to stop oscillations.

There are several methods of making this trap. One is to wind about 100 turns of fine wire on a dowel rod and to tune this inductance by means of a small condenser until oscillations cease. This tuning condenser may be two six-inch lengths of annunciator wire soldered to the two ends of the coil. These wires are twisted, constituting a condenser, until the proper capacity is found.

Another method consists in removing the "works" from a grid leak and winding about 100 turns on the glass tube. This inductance is then slipped into a .00025-mfd. condenser with grid leak mountings and wire removed or added until stability is attained.

If this trap is found necessary at all, the set cannot be neutralized until the trap is properly tuned, and little that is done to the remainder of the circuit will affect the frequency at which this amplifier oscillates when it is on oscillation bent. This is a phenomenon that has never before been described as far as the writer is aware. Coupling between amplifier, grid, and plate coils has no effect upon it, and in the Laboratory, a mid-tap coil a yard away from the plate coil and connected to the tube through twisted leads still caused the amplifier to oscillate. At times, the amplifier tube has taken as much as 20 milliamperes with 90 volts on the plate and negative 4.5 on the grid until the trap in the mid-tap had been properly fixed.

This trap circuit will tune sharply, and to make it more effective, some resistance should be added to broaden out its resonant frequency. This may be done by using resistance wire, or by placing an iron nail or screw in the grid leak tube. The first trap the writer made was constructed of wire wound on an iron nail hammered into the base board. Wire was added until oscillations ceased.

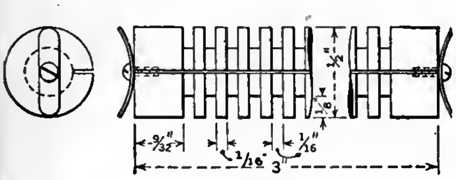


FIG. 11

The specifications for the choke coil for use in the Lab circuit are given above. Twenty slots are provided wherein No. 36 dcc. or enameled wire is wound until the slot is filled. The lead is then conveyed to the adjacent unfilled slot which is filled in the same manner.

OPERATING THE CIRCUIT

IT IS not difficult to neutralize this amplifier if proper precautions are taken. It is best to start experiments with a 199 type tube as the amplifier and to learn all the tricks with this tube. Then one may graduate to a higher gain tube like a 201-A which is more difficult to neutralize.

The detector is made to oscillate and a carrier wave is picked up. The neutralizing condenser is varied until tuning the amplifier condenser does not change the pitch of the beat note.

Less trouble will be had in neutralizing and controlling the set if both coils are toroids. Battery leads should be twisted and made into a cable, keeping them away from grid leads and radio frequency leads.

Commercial types of toroid coils may be adapted for use in this receiver without difficulty. It is only necessary to tap the coil in the proper place. It is not necessary to remove additional coupling coils which are provided by the manufacturers.

Coils may be wound on a rectangular form on which is placed some adhesive tape or absorbent material which is covered with collodion before the form is removed. The coil is then wound about a cylindrical center which makes a solid core.

It may be remarked here that toroid coils furnish an excellent use for enameled wire—and what experimenter is there who has not longed to use a supply of such wire that has been in the laboratory for a long time?

These coils have a low distributed capacity and will tune to a wide range of frequencies. Commercial coils are wound to be used with .0005-mfd condensers although there is no reason why they cannot be made for smaller capacities.

The present article will be followed with another giving exact constructional details of a complete toroid receiver of exceptional gain. Methods will be shown of winding traps, choke coils, and of operating the amplifier filament from alternating current.

It is hoped that home experimenters who assemble the circuit will give the Laboratory an opportunity to hear of their difficulties or successes.

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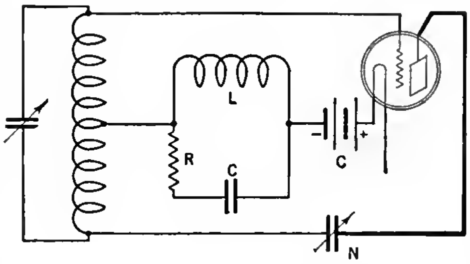


FIG. 12

The position of the tuned trap in the mid-tap of the amplifier

Something You Don't Know About Your R. F. Amplifier

IN SPEAKING of radio-frequency amplifier circuits, which use Rice neutralization, Mr. Henney analyzes a peculiar, phenomenon, which, to our knowledge, has never before been suggested.

"If the receiver seems to be inoperative, no signals coming through, or if the amplifier seems to oscillate without regard to the neutralizing condenser, or if a plate meter shows that the first tube is taking a large plate current, this tube is probably oscillating at a very high frequency.

This frequency is usually in the neighborhood of 3748 kc. (80 meters), and is controlled by the "leakage" inductance of the coil and the capacities attached to it. What actually happens is the following. The tuning condenser is practically a short circuit for the very high frequencies. In other words, the coil is an inductance with its two ends connected together. If the coupling between the two halves of the coil were perfect, the resultant inductance when the ends were connected together would be zero. Actually, however, the coupling is not perfect, the resultant inductance is not zero, and the circuit resonates to this leakage inductance and the capacities attached to it.

A trap tuned to the oscillating frequency and placed in the mid-tap will solve the difficulty since it puts enough loss into the circuit, at that frequency, to stop oscillations."

How to Pack Radio Sets for Shipment

How Manufacturers Avoid Broken Cabinets, Damaged Coils, Tubes, and Sockets—Suggestions for the Amateur Who Ships His Own Set

By STANLEY W. TODD

American Railway Express Company

HOW NOT TO PACK A RADIO RECEIVER

A woolen blanket will not afford sufficient protection for a set when shipped

A RADIO enthusiast who has gained quite a reputation for his skill in set construction, recently spent many days making a set for one of his friends who lived in another city.

When it came to the final step of preparing the set for shipment, this fan took an old woolen blanket and wrapped the set in it, and then put it in a wooden crate. That was ideal packing, he argued, for, of course, it would be all that was necessary for protection, and would prevent the fine mahogany cabinet he had gone to some pains to get, from being scratched or marred.

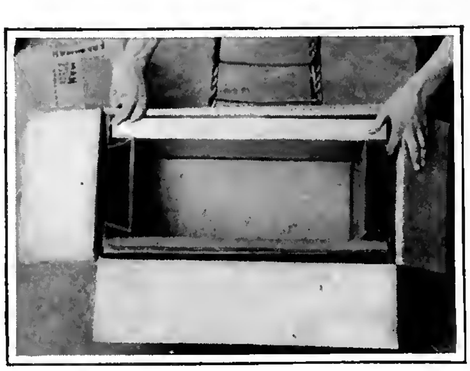
But on arrival, it appeared that the set had suffered severely by the trip, and when the tubes were put in the sockets and the battery connected, not a murmur came from the loud speaker. The man for whom it was made at once communicated with the builder and claimed that the express company had treated the shipment pretty roughly in getting it to him.

An express company supervisor, who had given much study to the rather difficult problem of packing radio shipments properly, was brought into the case. When he examined the container and found that only a heavy blanket had been used to cushion the set against the normal shocks and jars of transportation, he knew just where the trouble lay. It was apparent that the blanket offered little protection of this sort, which is considered absolutely essential in every good radio "package."

The average builder of a radio receiver, amateur or professional, handles a set very gingerly in carrying it around. He would consider it quite a problem if he had to take it a great distance by hand, always fearing that the fine inside adjustments would be disturbed. In transit, a shipment may be handled thirteen or fourteen times.

Proper cushioning has been found to be the only way by which the effect of such shocks and jars can be neutralized.

It took some time for transportation experts and box manufacturers to determine what was necessary to be done to pack radio shipments so that they would ride safely. This led to the development of what is known as the "air cushion carton," which most of the large radio manufacturers are now using. These are usually made to fit each particular size of set, and



COMMERCIAL PACKING FOR A MANUFACTURED SET

Inside the larger packing carton, usually made up of corrugated material, is placed more cardboard so arranged as to provide an air cushion completely around the set

the cushions, so called, are merely corrugated board, scored or bent in such a manner as to provide at least a two-inch open space between the inner wall of the outside carton and the top, sides, and bottom of the set. The shipping unit is thus a box within a box.

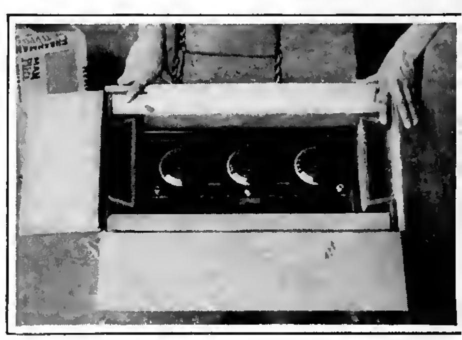
The air cushions hold the set in suspension and prevent the jars which the shipment may encounter in transit from reaching the delicate instrument inside. When put upon a flat surface, the cushions prevent the air from escaping, and that gives a spring-like quality, absorbing the shocks and holding the instrument tightly so that it cannot shift. Some manufacturers have taken the additional pre caution, where the sets are unusuall large or heavy, to place the carton in crate.

Most of the damage to radio sets, th express companies find, is encountered no when the manufacturer ships his receiver to his dealers, but when the latter refor ward the sets to customers, after havin taken them from the original package an replaced them again for shipping. The are not always familiar with the trick o putting the cushions in the proper position so that they serve the purpose of offsettin jars in transit, as intended. Fans wh make their own sets, of course, are les familiar with the importance of air cushion and much trouble is encountered by trans portation companies in handling thei radio shipments.

PROPER SHIELDING AGAINST BUFFETING

IT SHOULD be emphasized that neithe loose excelsior nor paper used for cushion ing absolutely neutralizes the shocks of or dinary handling, because when it is crushe down, especially if a wooden box is used practically every jar of a serious nature i transmitted to the set. There are too man fine adjustments in the average receive not to cause some trouble, if extreme car in handling is not encountered, especiall when the cushioning feature is disregarded

Damage often occurs to some of th handsome cabinets used by manufacturer because of the inherent weaknesses of th



PLACING THE RECEIVER IN THE BO

Air cushions are arranged on all sides. The onl step yet to complete is the placing of the cor rugated pasteboard on top of the panel material. The grain of the wood in the end pieces of a cabinet, for instance, should run crosswise and not lengthwise. Otherwise, when the end pieces are grooved out where the back panel fits, the wood is weakened and a slight shock will cause the ends to split with the grain. If the cabinets are made of green wood or unseasoned lumber, similar trouble may develop.

Panel breakage used to be quite common, because in a good many sets some of the necessary parts, like condensers, heavy coils and the like, were hung from the rear of the panel without support. In transportation, this weight proved too much and a cracked panel sometimes resulted. In the sets of to-day, with the large use of subpanels and the tendency to place the heaviest parts on the base, the panel is given much more consideration, and, therefore, rides without often encountering trouble.

Of course, common sense dictates that the tubes should not be left in the set when a receiver is shipped, nor should any loose equipment be placed in the cabinet. Obviously batteries should be sent separately

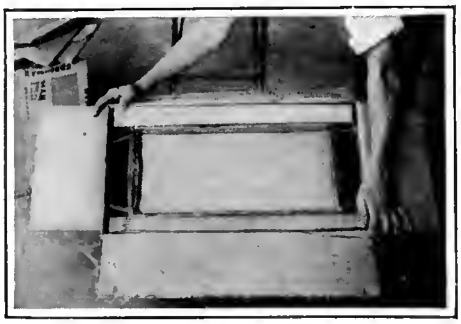
THE TOP AIR CUSHIONS

In this particular type of carton fit snugly over the panel of the receiver protecting the dials and the face of the panel. When shipped, this receiver will have cushions on all sides, thus reducing the chance of damage to an absolute minimum

and there are special ways for packing both dry cell batteries and wet storage batteries. Practically all of the manufacturers are using individual cartons for B batteries, thus removing any danger of short circuiting, while the standard crate for a storage battery is so made that it must always be handled "right side up." Such crates or boxes are made so that expressmen will have something to take hold of in handling them.

Much trouble in transportation has been encountered in handling shipments of loud speakers. The bell or horn of the type in most common use is made of wood or fiber, and is classed as "fragile." The parchment disc type cannot stand much rough handling. Most manufacturers use cartons made for their particular type of loud speaker, and most instances of damage in shipments have come in the reforwarding of them by dealers and individuals.

Here again the air cushion idea has helped to solve the problem. Express companies recommend the use of cartons sufficiently large at least to allow one inch on the bottom and top of the mouth of the bell. The base should be packed separately either in another carton or in a separate compartment in the carton holding the



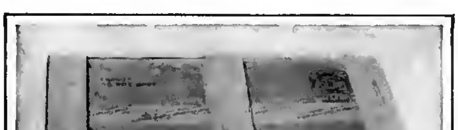
BEFORE SEALING THE CARTON

Note how the receiver is completely and firmly suspended by its interior case. The normal shipping jars will not dislodge the apparatus or damage the cabinet if similar precautions are taken whether or not the receiver is manufactured or home built. The amateur shipper may not be able to produce a box as workmanlike as the ones from the box factory, but he can easily apply the same principles and be sure of adequate protection for his set when it is shipped

bell. A hole should be cut in the cardboard which fits into the carton, to hold the neck of the horn firmly. At least one cushion or filler should protect the mouth of the bell from coming up against the bottom of the carton. "Fragile" labels and one "This Side Up" label on the top, assure proper treatment in transportation.

SHIPPING RADIO TUBES

As TO the packing of radio tubes, the leading manufacturers have adopted standard cartons which have proved satisfactory. These usually comprise a corrugated collar with a felt wrapping to be



SHIPPING CASE FOR A 30-POUND SET

Receivers which weigh more than 30 pounds will travel more safely with a light wooden crate around the corrugated packing case

placed around the tube, and the whole inserted in a special carton. This carton is not expected to prevent a tube from being smashed in case of an accident, but it is strong enough to protect the tube from injury, if it is held firmly, allowing no play in the package, and provides a cushion of some sort to protect the tube from shocks and jars.

Despite all precautions taken, there are still some cases of filament breakage. As this slender wire is less than one-fourth the diameter of a human hair, a slight jar may break it. A heavier shock will disturb or disarrange other elements inside of the tube, causing short circuits in the tube.

A fan who ships a tube only protected by the carton that he buys it in from the dealer is taking a big chance, as it was not intended to serve as a forwarding carrier. A tube carton should be placed in another strong container large enough to allow several inches of excelsior on all sides of the tube carrier. Tubes that have been used for any length of time should not be shipped, as the filament is exceedingly brittle even though the tube may still function, and may not stand handling.

In the express business, the employees have been so frequently cautioned regarding the need for extreme care in handling all kinds of radio shipments, that this traffic to-day is being given special attention.

SHIPPING THE HOME-MADE SET

Transportation companies prefer the use of air-cushion cartons, but where these cannot be obtained, the best packing material to use is excelsior. At least three inches of this material should be placed all around the receiver to insure safety in transit

A good many of them are radio fans themselves and know how delicate the set construction usually is.

Even though prices of receivers generally are lower than they were a year ago, it is undoubtedly false economy to attempt to skimp on the proper packing materials that will insure the set being properly handled in transit. If the average fan would give the same time and care to the packing of the set as he does to the construction and hook-up, much of the breakage encountered in the movement of the radio traffic would be avoided.

The transportation companies are seeking the coöperation of the public with the proposal, which seems to be fair, that if a radio shipment is packed with due regard for its fragile and breakable character, they will do their utmost to handle it properly during its travels.

Some Entrants in the $500 Prize Contest

A few of the Sets Submitted in the RADIO BROADCAST-Eveready Contest for a non-radiating Short-Wave Receiver

THE illustrations on these two pages depict some of the many interesting short-wave sets that have been received in the RADIO BROADCAST-Eveready contest for a non-radiating receiver to operate on the short amateur waves. With the close of the contest, the process of elimination is actively under way, and the winners will probably be announced in the July number of RADIO BROADCAST. This contest was announced for the reason that practically all short-wave sets now in operation radiate more or less violently, and since it has long been the policy of this magazine to frown on "bloopers," it has not been possible to de scribe in the editorial pages of the magazine a simple and efficien receiver for the higher frequencies.

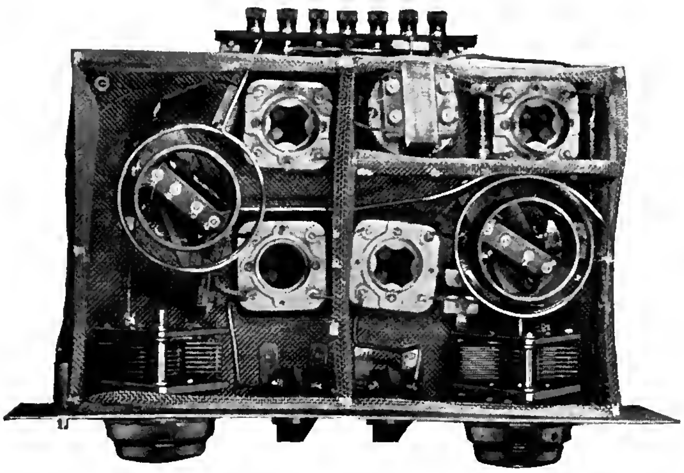
From the manuscripts submitted, fifteen have been chosen a the most promising from the standpoint of their non-radiatin qualities, simplicity of construction and operation, and ori ginality. From these fifteen, the judges will choose the three tha seem to possess the highest qualifications, and these three will b described in RADIO BROADCAST.

The receivers illustrated here are not chosen with any particula idea in mind, except to show characteristic receivers. The indicate nothing whatever of the relative merits of the fifteer from which the final choice will be made.

The receiver at the left came from W. S. Pritchard, of 430 Euclid Avenue, Cleveland, Ohio, and uses four tubes, two detectors an oscillator, and one stage of audio-frequency amplification. Com plete shielding is used to eliminate stray couplings and, althoug the photograph does not show it, there is a brass cover for th receiver, making it a very attractive piece of work.

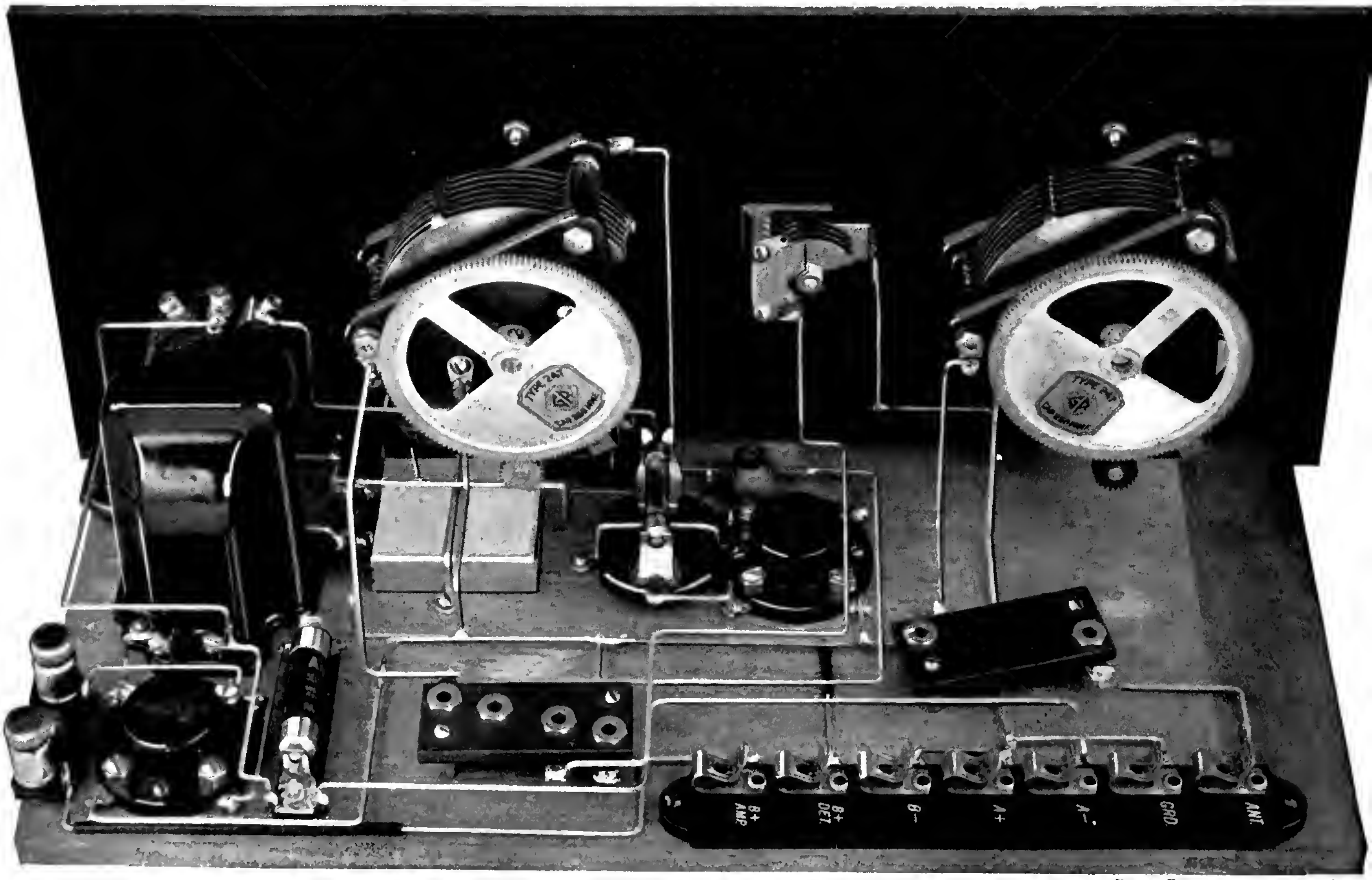
The receiver below was constructed by L. W. Hatry, 46 Sout Marshall Street, Hartford, Connecticut—one who has long bee known in the amateur game. This receiver is typical of the ex cellent construction that appears in the best amateur sets to-day and gives in good detail the relative arrangement of parts, in cluding the disposition of the sockets for the plug-in coils.

On page 129 are three more short-wave receivers, the one in the upper right representing the product of Mr. J. Kriz, 1628 Rigg Place, Washington, D. C. It is a three-tube set with a stage o radio frequency amplification before the detector. The amplifie and detector operating at radio frequencies are tuned with a gang condenser, so that tuning is a simple matter, in fact no more



RADIO BROADCAST Photograph

THE ENTRY OF W. S. PRITCHARD, CLEVELAND, OHIO



RADIO BROADCAST Photograph

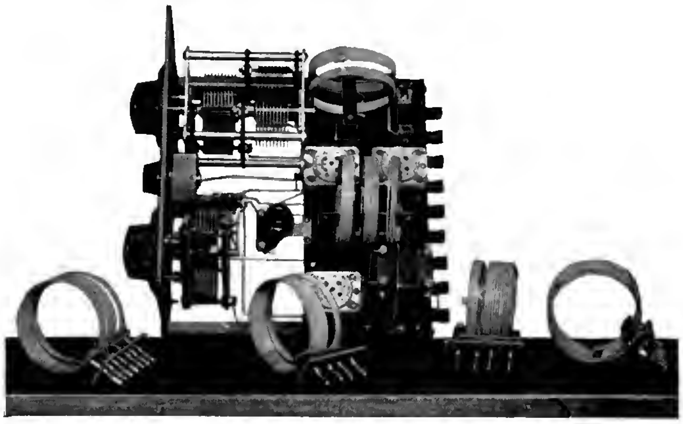
THE ENTRY OF L. W. HATRY, HARTFORD, CONNECTICUT complicated than with the ordinary Reinartz set. In the RADIO BROADCAST Laboratory it seems to have a penchant for southern stations, as XDA, Mexico City, has been heard pounding away at a great rate for many successive evenings.

The second receiver on this page was built by Robert H. Freeman, East Orange, New Jersey, and is a four-tube set. It shows an excellent arrangement of parts, with a minimum of gear between the coils and condensers.

The receiver below was constructed by another well-known amateur, F. Cheyney Beekley, Glastonbury, Connecticut. In this case, the apparatus is mounted on a metal sheet which has been bent so that it forms a continuous shield, a part of it being used as panel and a part as base board. A Silver-Marshall coil is used as inductance, and all parts carrying radio frequency currents are kept well away from the shield.

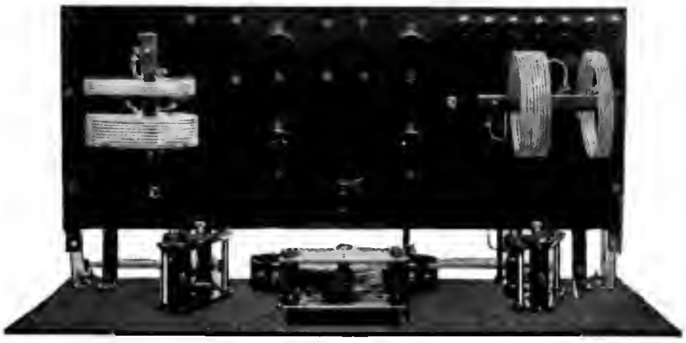
As this is written, tests are under way to determine the relative sensitivity and freedom from objectionable radiation of the various receivers. A fixed oscillator of low power is installed in the Laboratory and signals from it are picked up at the shack which houses 2 GY, about 400 yards distant, and the audibility measured. All receivers are compared with a Reinartz circuit set temporarily used as a standard and which has proved to be very sensitive and simple to handle.

The first test for radiation is a simple one. The receiver is made to oscillate with 90 volts on the detector, and is attached to an antenna at the Laboratory. If its signals can be heard at the shack it gets a poor rating with regard to radiation. It has been found that the Reinartz receiver puts R3 signals into the shack under these conditions, and it forms one method of communication between the Laboratory and 2 GY. If the signals from the receiver cannot be heard, the distance is decreased until they are audible and equal in strength to those of the Reinartz, and then points are awarded. While there is no reason why any operator should use 90 volts on the detector tube, such practice in our tests will determine conclusively the maximum distance at which the receiver will cause trouble to other listeners.



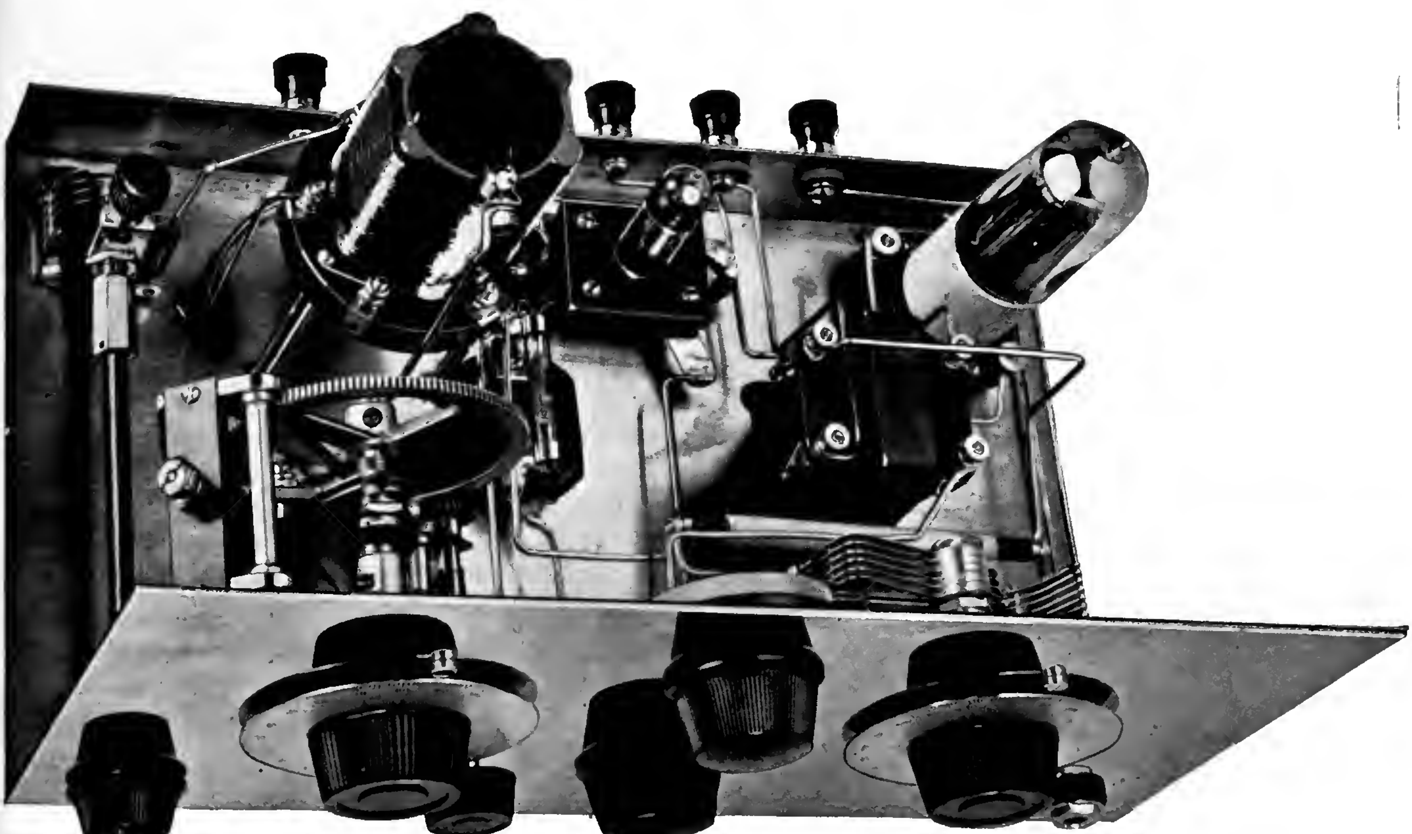
RADIO BROADCAST Photograph

SET SUBMITTED BY J. KRIZ, WASHINGTON, D. C.



RADIO BROADCAST Photograph

CONTEST RECEIVER OF ROBERT H. FREEMAN, EAST ORANGE, NEW JERSEY



RADIO BROADCAST Photograph

ANOTHER SET, SUBMITTED BY F. C. BEEKLEY, GLASTONBURY, CONNECTICUT

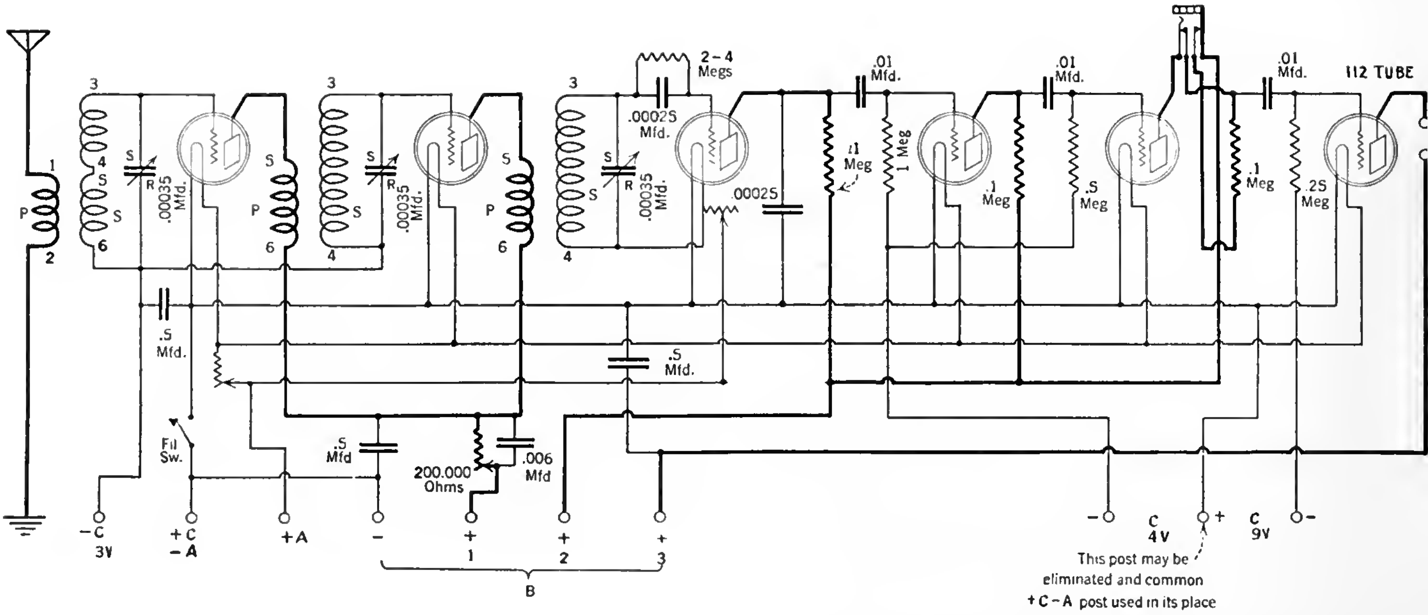


FIG. 1

The modified Silver circuit employing a grid leak and detector, r. f. oscillation control, and separate C and B battery connections is shown here. The changes are more evident when one compares this circuit with the original circuits appearing in the November, 1925, and January, 1926, RADIO BROADCAST or with the circuit shown in Fig. 9, page 132. The B battery terminals, 1, 2 and 3 are for the 90, 90-135 and 135 volt taps of the battery respectively

Progressive Modifications in the Silver Model 1926 Receiver

Changes Which Will Improve This Receiver, Built by Many Readers of RADIO BROADCAST

By THE LABORATORY STAFF

"I HAVE made several changes in the Model 1926 Silver receiver (described in RADIO BROADCAST for November, 1925 and January, 1926), all of which have added to the selectivity, sensitivity and tone quality of the receiver." This, in the main, is the gist of numerous letters received by RADIO BROADCAST. The writers usually complete their letters with a brief outline of the changes made.

In the RADIO BROADCAST Laboratory, we have been conducting some very interesting experiments of our own on this receiver. Our report, with which is blended much of the valuable information gleaned from those who have built and experimented with this set undoubtedly will aid those who have had and are having considerable difficulty in making their own model of this set work properly.

In all probability, it will be found helpful to provide the receiver with a terminal strip having 12 posts. It is doubtful whether the majority of manufactured battery cable cords have enough leads so that it alone may be used to connect the receiver to all the batteries used. Several of the terminal posts may be eliminated or one lead may be used for several purposes, as in the case of the—A—B+C lead or post. This would reduce the number of battery leads or posts to eight, since there are two+C posts to be provided for. By including small blocks of C battery within the cabinet and directly wired to that part of the circuit to which it applies, the number of battery leads may be cut to five: 1. minus A minus B; 2, plus A; 3. plus B 45; 4. plus B 90; 5. plus B 135. Reference to the modified circuit diagram, Fig. 1, will make this suggestion quite evident.

IMPROVING DETECTOR SENSITIVITY

ONE of the main changes in the receiver proper is the replacement of the detector C battery with the more standard grid leak and detector. In including the grid leak and detector in the circuit, it is merely necessary to disconnect the wire leading from the detector secondary to the grid post of the detector socket and insert in this opening, the grid leak and detector. A .00025-mfd. condenser is satisfactory and is shunted by a leak of 2 to 4 megohms. The lower side of the detector secondary coil, terminal No. 4, does not connect to the minus C line but is brought directly to the positive terminal of the detector socket. These changes are shown in Figs. 1, 2 and 3.

The next change comes in connecting the lower end of the r.f. plate coils of the first and second stages directly together and then leading this junction to one side of the 500,000-ohm variable resistance which previously has been disconnected from its original place in the circuit. The other side of the resistance connects to a separate B battery terminal or cord. It is well to by-pass the variable resistance when in its new position with fixed condenser ranging from 0.006 mfd. to 0.05 mfd. Where this change is found unsatisfactory in that the control of oscillation is over only a small part of the 500,000-ohm resistance, then it will be necessary to substitute for this unit, one having a maximum of 200,000 ohms. See figs, 6 and 7.

TABLE I

TUBE	USE	B VOLTAGE	C VOLTAGE
201A type	in the r.f. circuit	67.5 or 90	— 4.5
" "	1st a.f. (Transformer)	90	— 4.5
" "	1st and 2nd a.f. (Resistance)	90	— 1.5 to —3
High-Mu	1st a.f. (Resis. and Imped.)	90 to 135	— 1.5 to —3
"	2nd a.f. (Resis. and Imped.)	90 to 135	— 1.5 to —3
112 type	Last a.f., Power	135	— 9
		157.5	—10.5
		180	—18
		225	—22.5
210 type	Power Stage	250	—18
		350	—27
		425	—35
120 type	Power Stage	135	—22.5

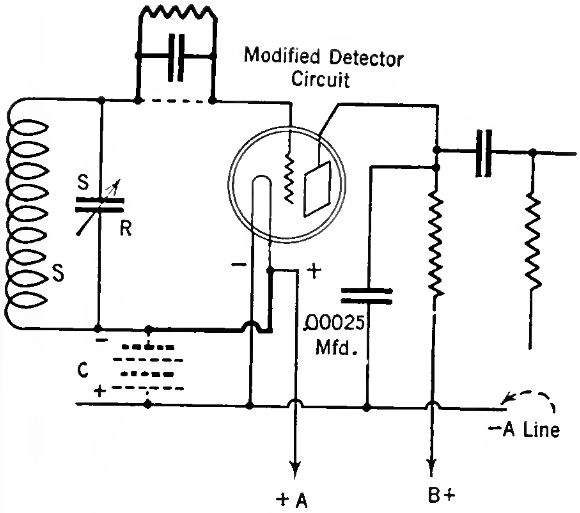
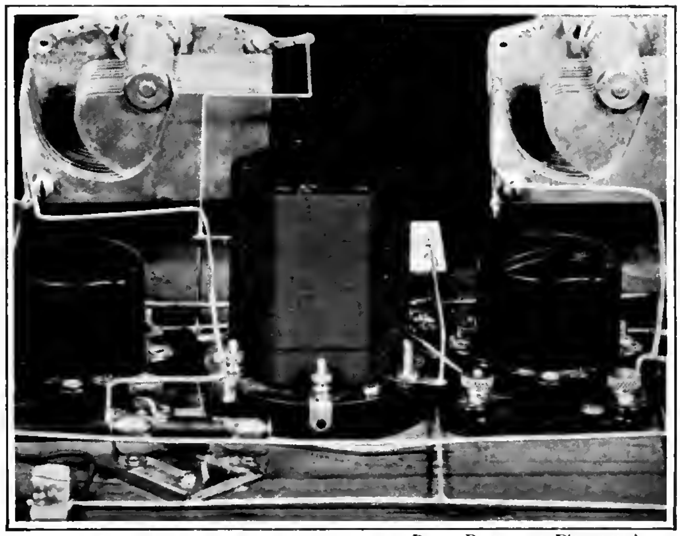


FIG. 2

In substituting a grid leak and condenser for the C battery method of detection, the return or lower side of the detector secondary circuit must connect to the positive terminal on the detector tube socket. These changes are outlined here

FIG. 3

One of the simplest changes is in substituting a grid leak and condenser for the C battery method of detection. The connections for the change are outlined in the circuit Fig. 2



Radio Broadcast Photograph

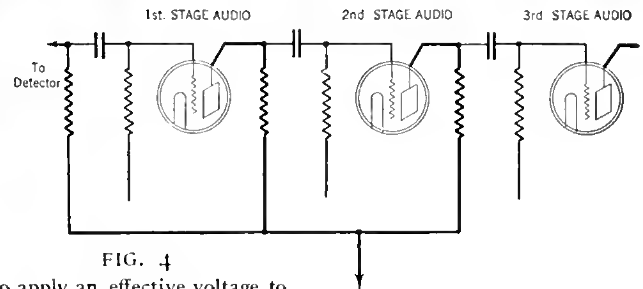
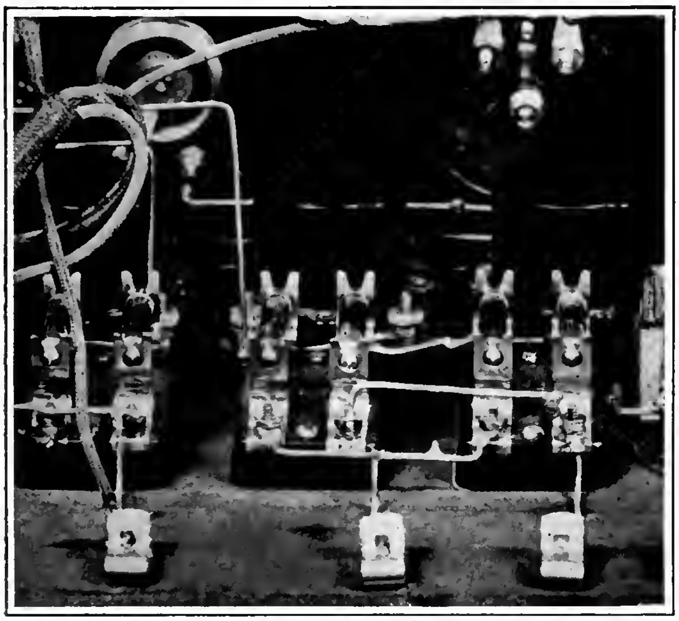


FIG. 4

To apply an effective voltage to the plates of the detector and first and second stage audio amplifiers, the lower side of the plate resistances are connected to a separate B battery terminal post as shown here. Since in the loud speaker circuit, there is no high resistance, the plate of the last tube has a full 135 volts applied to it



Radio Broadcast Photograph

FIG. 5

Since it is not possible to make use of the battery cable cord for all the terminals, it is necessary to employ more terminals for the additional battery connections. These are provided by the use of the Fahnestock clips as shown

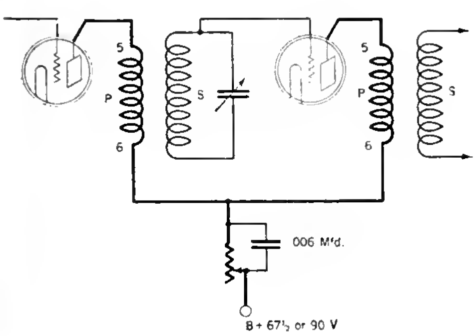
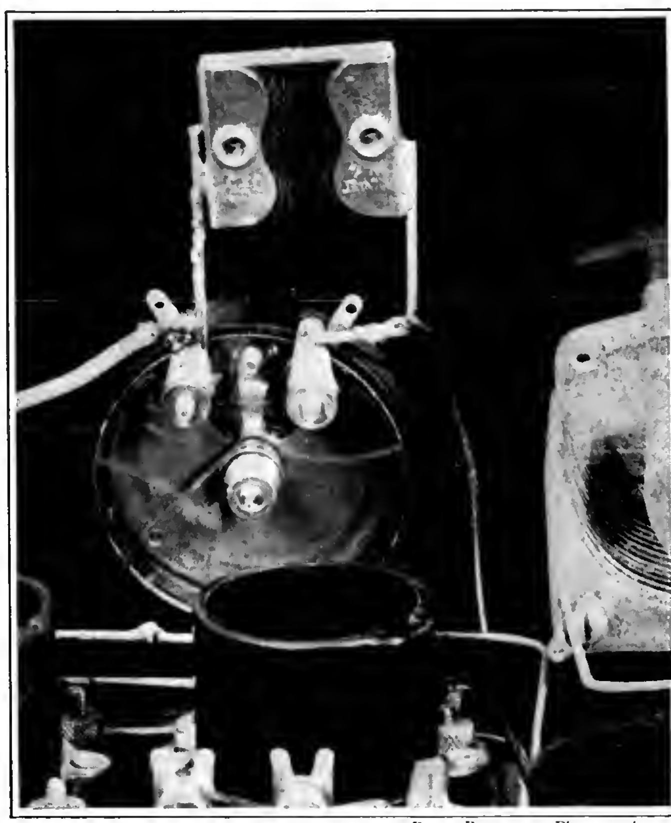


FIG. 6

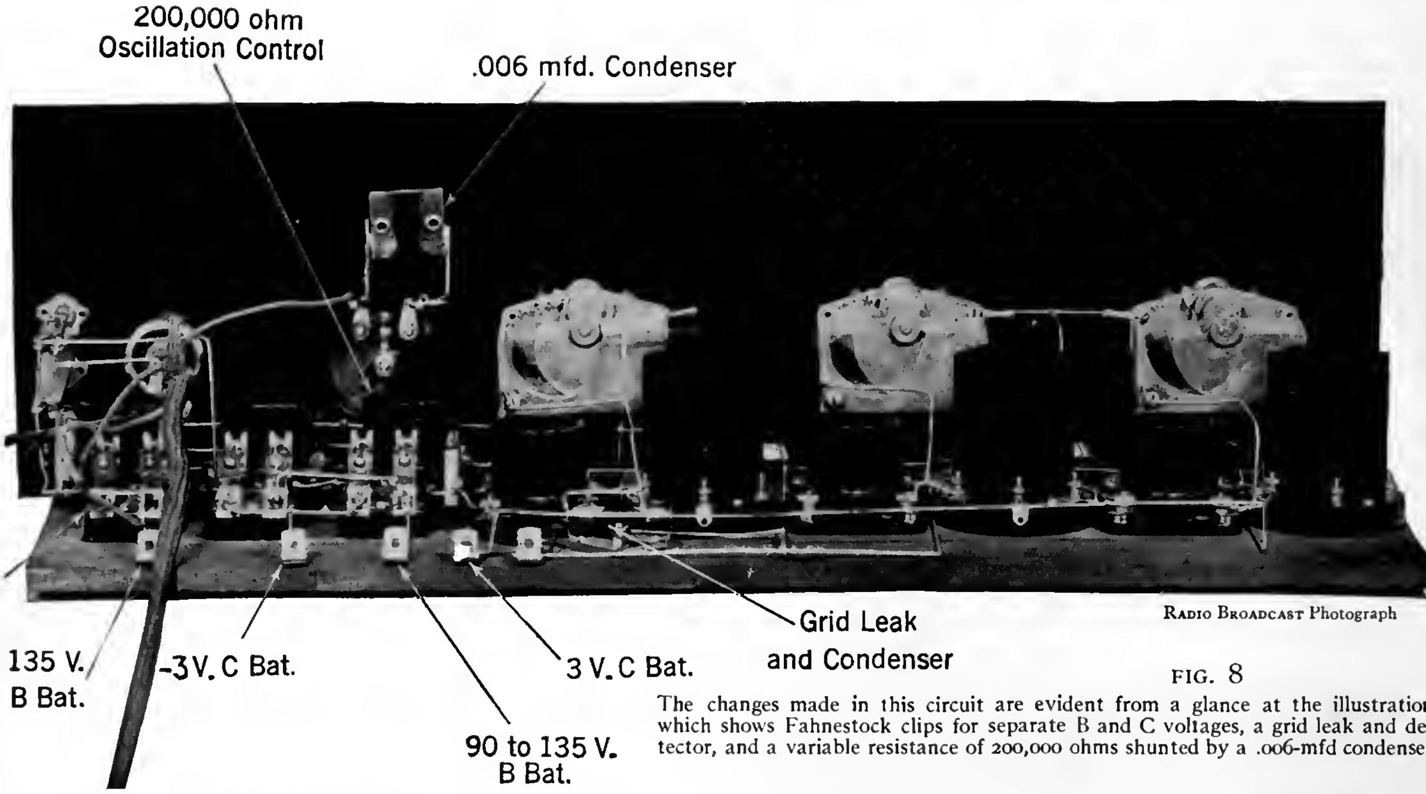
To control satisfactorily, oscillation in the radio frequency stages, a variable high resistance unit is connected in the radio frequency plate circuits as shown. This resistance, for best results, should be by-passed by a fixed condenser. Various values may be tried. That suitable in Radio Broadcast's Laboratory tests was an .006-mfd fixed condenser. The 500,000-ohm variable resistance employed in the original Silver circuit will usually be found unsatisfactory in the modified circuit. One having a maximum of 200,000 ohms such as the Centralab No. 201, or 203 is recommended



Radio Broadcast Photograph

FIG. 7

The position of the variable resistance is not changed in the modified receiver. Merely replace the 500,000-ohm unit for one having a maximum of 200,000 ohms



Radio Broadcast Photograph

FIG. 8

The changes made in this circuit are evident from a glance at the illustration which shows Fahnestock clips for separate B and C voltages, a grid leak and detector, and a variable resistance of 200,000 ohms shunted by a .006-mfd condenser

PROPER B BATTERY FOR THE PLATES OF THE AMPLIFIER TUBES

WHERE resistance-coupled, audio-frequency amplification is employed, the plate return side of the detector and first and second stage plate circuit resistances connect together and then lead to another separate terminal or cord. This is so that B voltages in excess of 90 may be applied to the first two stages of resistance audio amplification without affecting the radio-frequency amplifiers. In the original circuit diagram, the connections were such that not more than 90 volts could be applied to the plates of the first two audio amplifier tubes without, at the same time increasing the r.f. plate voltage. This change is outlined in Figs. 4 and 5.

The plate return of the last audio stage should connect to its own terminal for a separate B voltage, which may be still higher than for the first two stages. In this last stage a semi-power tube may be employed to the best advantage.

In all the stages, both r.f. and a.f. it is decidedly necessary to be sure that one uses the correct C battery as indicated in Table 1.

These same changes as made in the resistance audio amplifier will hold good for both transformer and choke coil audio amplification with the exception that in these cases, lower B voltages will be found satisfactory. In the latter two types of audio amplification named, a separate connection from the plate circuit of the detector tube will be found necessary to prevent the detector from continuously oscillating. The extra lead may well connect to the 45 volt B plus terminal of the B battery.

In summing up, then, the modifications which will be found beneficial are:

1. Provide separate leads for first and second r.f. stages, first and second audio stages, and last stage; also detector stage, if other than resistance coupled amplification is employed.
2. Insert a 200,000—or 500,000-ohm variable resistance in series with plates of both r.f. tubes and B battery terminal.
3. Eliminate C battery for detector and replace with grid lead and detector.
4. Use proper C battery voltage on r.f., first and second a.f. and last a.f. stages.
5. Use a semi-power tube, with proper B potential and grid bias, in the last audio stage.

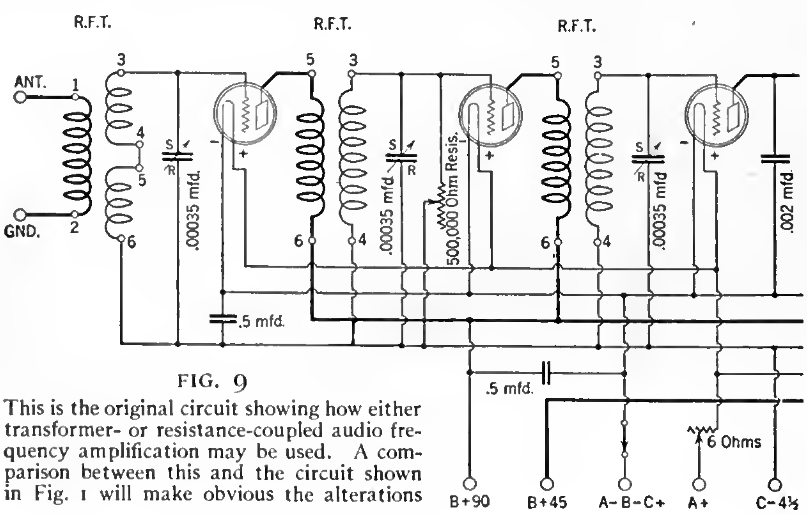
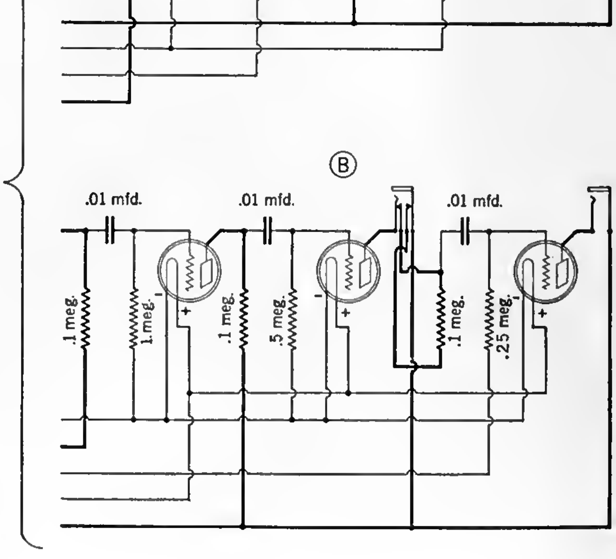


FIG. 9

This is the original circuit showing how either transformer- or resistance-coupled audio frequency amplification may be used. A comparison between this and the circuit shown in Fig. 1 will make obvious the alterations



Conducted by – John Wallace

Why it is Difficult to be Funny Over the Radio

THAT radio programs are improving in quality, even the most lugubrious crape-hanger must admit. And we make haste to admit it. The healthy condition of competition existing where several hundred broadcasters are daily vieing for the listeners' cherished ears has, of necessity, resulted in a considerably higher level of entertainment.

Need we say that them kind words do not apply as a blanket compliment to the whole brotherhood of broadcasters. Many stations are just as bad as they were two, three, or four years ago. But the stations that have progressed have done so by such leaps and bounds that, even though a minority, they have greatly boosted the average rating of broadcast fare.

Nor does the encomium apply to all departments of broadcasting. Certain types of program have improved while others have lagged behind. By far the greatest advance has been in music, both high- and low-brow. We doubt if radio will ever offer any better jazz bands than it now furnishes (though, with the help of the jazz composers it may well offer better jazz music). There are highly skilled syncopators to be heard from every part of the country.

And real music is being heard more and more frequently. A fair smattering of the best symphony orchestras are regularly on the air. The roll of opera stars and concert artists who have been heard once or oftener has reached amazing proportions. Sports announcing is another program item that has evinced great progress. Others could be enumerated.

But tossing aside, for the moment, our horn, and picking up our hammer, we point, with tears behind our eyelids, to one type of program that has improved nary a whit. And that is the "humorous" program. All great art, unless it be too infernally sublime, has an element of humor in or about it. But radio, the most loudspoken "art" of this Age of Progress is lamentably devoid of this enlivening feature.

This is due to one of two things: either the program directors haven't been spending enough sleepless nights cogitating on this subject, or—it is inherently impossible to put across humor through the medium of radio. Which of these reasons is the correct one we have not yet doped out. Perhaps you have? At any rate we'd be very much interested in hearing your opinion on the subject.

Occasionally, very occasionally, we hear something that reassures us that humor is broadcastable. For instance we have howled heartily at Ford and Glenn. The "Happiness Boys," Billy Jones and Earnest Hare, who hold forth over WEAF Friday nights, are consistently funny. And there are a few others. In speaking here of humor we have in mind specifically monologues and wit-and-repartee skits, and do not mean to include humorous songs or humorous musical skits, which get by partly on the strength of the music.

In support of our alternative solution of the problem it might be observed that the radio audience differs from the theater audience in that it is not a "crowd." It presents no "group mind" to the radio entertainer, and hence is a difficult thing to deal with. We refuse to laugh at a radio wise-crack for perhaps much the same reason that we don't laugh out loud at a funny paper we are reading in the street car. The contagion that sweeps a laugh through a vaudeville house is denied the listener-in. Efforts of the radio clown to inject the element of *rapport* by laughing with his audience invariably meet with dismal failure. Nothing in the world sounds more mournful and mirthless than a loud "haw haw" as conveyed by radio.

WILL ROGERS

One of the best known stage humorists in America, whose opinions on humor by radio are presented in this department this month. Entirely parenthetically, Mr. Rogers is reported to have returned from Florida with the remark that the real flower of that state is now the all-day sucker

As to what the humorists themselves have to say on the subject, we append the following report compiled by Myra May from interviews with three prominent comedians, Billy B. Van, Will Rogers, and Joe Cook.

"The hardest thing for the comedian to bear in mind when talking over the radio," says Mr. Van "is that the audience is looking at him through ears and that he must appeal to them through their mental eyes. This means that he can't shamble out with an awkward gait and look around him with a bewildered expression while the spectators take in the details of his baggy trousers, enormous shoes, red nose and absurd little hat cocked on one side of his head. He can't depend on any stage properties to bring out an obscure point. He has to attract the attention of his audience immediately and explain his properties as he goes along.

"He is allowed much less leeway than on a stage. He can not walk away from the microphone and leave his invisible audience wondering what he is doing. He can only do his work as well as possible, secure in the knowledge that good work will hold the people who listen-in as surely as it holds those who sit in front of the footlights.

"There are, moreover, certain very positive 'don'ts' that govern radio humorists. Diction must be perfect, voice resonant and every syllable clearly enunciated. Much of this is accomplished by word substitution, because certain words do not carry well. The letter 's' for example never goes over the air distinctly. So that if the comedian is telling a story where on the stage he would use the word 'string,' he must substitute 'twine' for the benefit of his radio audience.

"In telling a joke, there is always the grave danger that the point won't be clearly emphasized. Perhaps the last sentence which usually contains the pith of the story will be distorted and the listeners will have waited in vain for the humor. They will have endured the long-winded explanation that led up to the climax and then missed the whole point. As a result, the radio comedian tells his story much more directly than he would on the stage, he can not allow any rambling from the main point, any loitering by the wayside and yet he must not be too abrupt, too direct.

"Radio, however, has brought a great contribution to humor in that it has clarified the jokes of the professional merrymaker. Where a slight innuendo, a double meaning that was slightly *risqué*, could be used on the stage, it is absolutely taboo on the air. Only the cleanest of clean humor, entirely free from suggestion, is permissible. Considering the millions of people that may be listening-in and the little children that are probably part of the audience, this is right and proper.

"The comedian is considerably hampered by this very diverse audience. He can not tell witticisms that appeal locally, he can not tell stories that hold a race, a class or a religion up to ridicule, he can not make a pun that is complicated, he cannot jest of things which are not familiar to the every day life of his hearers."

Says Will Rogers: "Talkin' over radio is like talkin' over the footlights. When I'm most serious, people think I am tryin' to be funniest. Lots of times gags I could swear would get a big laugh, fall perfectly flat. You never can tell what is going to strike the public funny. Generally I make up my gags as I go along. Best ones I ever pulled come to me all of a sudden while I was killin' time trying to think of something to say.

"'Swinging a rope is all right,' I remember saying, 'when your neck isn't in it. Out West where I come from they won't let me play with this rope, they are afraid I might hurt myself.' Well, the audience started to laugh and forgot to look at the lariat. I was saved. After that, I started to make remarks regularly until the time come when I hardly did anything with my lariat.

"Now when I talk over the radio, I sure don't need a rope. Course, I can't hear whether the folks are laughin' at my gags, but that's a pretty good thing after all. I jest imagine they laugh, whether they do or not, and that way puts some heart in my act. If I was to hear them not laughin', it'd like to break my heart."

BILLY B. VAN

Another humorist artist with words and ideas. His impressions of the possibilities of humor on the air are quoted for the first time

Joe Cook made his radio debut not long ago.

"At first I found myself talking too fast because I was rather nervous," he confesses, "but inside of about three minutes, I had caught the spirit of the thing. I felt as though I were really talking direct to my audience. Throughout the whole time I was on the air, I was deathly afraid I was mechanical, that I sounded as though I were talking into a record instead of joking with a real flesh and blood audience.

"I don't want to pose as a radio expert, for I have really had very limited experience. So far, however, I have told the same stories through the microphone that I tell over the footlights. In time, I believe that there will be specialized humorists who will write material especially for the radio. This material will probably be very much cleverer and more subtle than the usual line of patter in use to-day, for when you appeal strictly to the ears and lack even the prop of personality, you must create proportionately brighter quips to hold your audience.

"My radio act is practically the same as my stage, except that I try to put more unction in the former. On the stage, I can juggle with balls, bottles, ladders, musical instruments; on the radio, I can juggle only with my voice and play the musical instruments."

Why Radio Cannot "Educate"

WE HAVE never emitted loud whoops and hurrahs in these columns concerning the educational potentialities of radio. And for the very simple reason that we do not believe that radio can educate. To educate, according to Mr. Webster, is to "develop or discipline the mind by systematic instruction or training." This, radio is not likely to do.

But most of the blah we read about radio as an "educational" factor is sincere enough, and can be made true enough by the simple device of substituting the world "informational" for "educational" wherever the latter appears. For radio certainly can inform In the space of an hour's random dial twisting we are likely to glean information on any subject from the Care and Nurture of White Mice to Efficient Methods of Lubricating a Traveling Crane.

While we are still skeptical about the ultimate value of the thousand and one radio extension courses offered by many colleges throughout the country, we are quite amenable to the arguments offered by one Joy Elmer Morgan of the National Educational Association in favor of the use of radio as an ally of primary education. For the fact that radio is a puny educational force while standing on its own legs doesn't argue that it can't be put to some good use with some better established educational medium to cling to.

Mr. Morgan urges that radio receiving sets be given a place in the class room. Among the 25,000,000 school children in the United States, he points out, there are probably a million who are studying approximately the same thing at the same time. Says Mr. Morgan:

JOE COOK

Who tells his opinions of the difficulties o "putting over" humor on the air. Mr. Cook a favorite on Broadway, is perhaps best knowr for his impersonation of the four "Hiwayians"

It would be possible to take some selection ir literature that every child should know and hav it read by some such master voice as Juli Marlow's. It would be possible on holidays such as Washington's Birthday, to have note authors read from their own selections. N child could listen to Edwin Markham read hi noble poem, "Lincoln the Man of the People," without getting a fuller appreciation of Abrahan Lincoln and a finer feeling for poetry.

It would be possible to have musical selections both vocal and instrumental, played to a nationa audience of school students. Geography coul be made a rich adventure by introducing fre quent talks by men and women who had recentl visited areas which the children were studying There are also large possibilities for radio in th improvement of instruction. More than hal the teachers of the United States have had les than two years of training beyond the four-yea high school.

Were there a radio in every school, it would b possible to broadcast master lessons and reci tations in various subjects which would be ric in suggestions to younger and inexperience teachers. There is another angle that is mos important. Teaching is an arduous occupation There are long hours of uninterrupted strain To break this strain a few times during the da by genuinely helpful inspirational material ove the radio would enable the teacher to come bac into the day's work with fresh vigor. These ar just a few of the possibilities.

Mr. Morgan does not mention it, but Oakland, California has conducted an experimen (through KGO) in the use of radio in teaching i the schools, with results that the Oakland schoo authorities declare to be most satisfactory. I fact the situation in Oakland has passed th experimental stage and the system has bee adopted as a fixture. A nation wide extensio of this practice seems inevitable.

Of course we who learned our three R's in th dark ages before radio need have no fears tha the infant generation of readers and writer and arithmeticians is going to learn any mor with radio's help than we did without it. Bu still, we in our day, didn't have to risk our slende young necks on the way to and from schoo dodging speeding automobiles, so it seems onl fair that the children of the machine age b entitled to whatever of good machinery has t offer.

Let the normal schools hasten to offer a cours in The Quick and Careful Tuning of Radi Receiving Sets. Perhaps it might be given b radio!

FREDERICK WILLIAM WILE

Washington special correspondent and political observer, who broadcasts decidedly interesting talks every Thursday evening through WRC and WJZ. His subject is "The Political Situation in Washington," and if you enjoy keen observation and well done verbal reporting, you had better hear him

Esperanto as the Interational Radio Language

WE HAVE yet to be convinced that Esperanto either can or should be made an international language. Our prejudice against this coined auxiliary tongue is based on several, what we consider good, reasons. But we have a sincere respect for the tenacity of the Esperanto propagandists, who certainly have little personally to gain by its promulgation.

We are in receipt of a letter from Robert S. Woolf, American secretary of the International Radio Association, from which we quote:

There is but one solution to the problem which confronts successful world-wide broadcasting, and that solution is the idea of an international, auxiliary language. From the time of the Roman Empire there have been thoughts and schemes for a single world tongue; many have been invented, tried, and found wanting—but there is a language which in actual practice has been proved suitable. That language is Esperanto.

In its grammar and its system of word-building, Esperanto is the extreme of simplicity. An educated person can learn it well for reading, writing and speaking in three months of ordinary study. After a few hours' study one can take up correspondence in the language with interesting people in all parts of the world, thereby materially increasing one's knowledge and international viewpoint.

Particularly in radio use Esperanto has been found to be the only suitable world language. Beginning with a speech from WJZ in Newark, June 19, 1922, about Esperanto as the coming world language, the number of stations broadcasting about and in Esperanto has grown proportionately with the increase in the number of radio stations. In 1922, five discourses about Esperanto were broadcast in America and Europe. In 1923 about fifty such items were on the air, more than two hundred in 1924, and during 1925 approximately twenty stations on both sides of the Atlantic have broadcast regularly in Esperanto. Many stations have been giving lessons in the language on the air, in the United States such lessons being broadcast by WRNY of New York, the station of *Radio News*, which magazine has been an ardent supporter of Esperanto as the only suitable auxiliary language for international radio use. A recent report from Germany states that every station in that country is now giving a weekly program in Esperanto.

What the Listeners Say They Want

THE management of station WJZ during the last two months circulated 10,000 questionnaires covering all of the important phases of broadcasting, so that the impresario in making up the programs would know just what the public most desires in the form of radio entertainment. The questionnaires were sent to all who wrote to the station reporting on reception of the 50-kilowatt transmitter.

The questionnaire was impersonal. No one was asked to sign his name. Each questionnaire was accompanied by a stamped addressed envelope. More than 4000 were completely answered and returned to the station. The results have been tabulated, under the direction of statistician, and they show what broadcast listeners prefer to hear on the radio.

Classical music was 33 per cent. more popular than jazz.

The answers revealed that orchestral music is the most popular. The other instrumental music is rated as follows: bands, symphonies, violin, organ, piano, 'cello, saxophone and cornet. In the instrumental group, quartets were half again as popular as trios and twice as much in favor as duos.

Relative values of the service end of the programs showed news is 25 per cent. more popular than time signals and sports, which ranked second and third respectively. National and local news broadcasts ranked about equal in importance. The other service features were voted for as follows: stock reports, financial reports, road conditions, agricultural information and cotton reports.

The most popular sport broadcast in the United States is baseball, according to the questionnaire. Baseball was 10 per cent. higher than football, which received the second highest vote. The other sporting events ranked as follows: boxing and horse racing. Hockey did not show up well in the votes submitted by listeners in this country, but the Canadian answers placed hockey in first place as the favorite sports broadcast and horse racing was second. Baseball received a few Canadian votes. Canadian votes for football were very few.

Travelogues ranked far ahead in the field of talks. Scientific topics were second, with the other subjects voted for as follows: politics, health, literary, economics, art, debate, forum, and beauty.

The questionnaire clearly shows that men announcers are more popular than women announcers. Several spaces on the questionnaire were provided so that radio fans could make comment on the art of announcing. The general complaint was that the announcers do not give the station call letters frequently enough. Some complained that there are too long pauses between selections and that the announcers in many cases talk too fast. Other suggestions offered to improve announcing were: Stop the announcers from trying to be humorous; make the announcers be brief and eliminate broadcasting lengthy descriptions of selections or the life story of the composer.

There seems to be a preference for programs broadcast by a chain of stations linked with a city station where there are plenty of artists. One listener expressed the opinion of many with the answer. "Better programs are generally put on by a chain of stations than any one station can promote." A number of Pacific Coast listeners commented upon the fact that it would be a good plan to have a chain of stations in the Far West linked by wires with New York.

Broadcasting of church services on Sunday were commended by many who answered the questionnaire. Many specified their religion but did not express a desire for any particular denominational service on the radio. KDKA's church service won special mention in many cases.

Concerning Radio Plays

PRAISE from Heywood Broun, a keen observer and critic, as quoted from his column in the New York *World:*

I am less sceptical than I was once about the potentiality of broadcast drama. I have heard several plays upon the radio and never with delight. But recently John Drew appeared during the Eveready Hour and when he did a snatch from "Rosemary," dramatic illusion was established. He did succeed in making a situation become alive and take on poignance. Given sufficiently high skill on the part of the performer, it is extremely difficult to set a boundary and say, "Beyond this point the radio is ineffective."

And the following remarks by George Arliss,

JUDGE K. M. LANDIS AND WILLIAM WRIGLEY, JR.

They are lending their august presence to the studio of KFWO at Santa Catalina Island, California. Just why, Major Lawrence Mott, owner of the station (try to find him in the picture), failed to inform us

THE A & P GYPSIES

Who are one of the steady features of the week's radio program heard through WEAF, WEEI, WJAR, WCAP, WWK, and WCCO every Monday evening from nine to ten, Eastern Time. The orchestra is under the direction of Harry Horlick

who makes sanguine prediction that the radio play is destined to be a greater dramatic art than the motion picture:

The great value of the radio play, is that it brings to its listeners what the motion picture never can give, the literature of the theatre. It is rather easy for most people to visualize the setting, or surroundings in which a story takes place. But it is almost impossible for them to supply the conversation, which, after all, is the literature of the drama.

In the plays of Barrie, of Pinero, or O'Neil, the charm lies in the spoken words. When they are produced in pictures the audience sees only the story in its proper setting, flitting across the screen. They must supply the conversation themselves, out of their own experience, in their own vernacular. But the radio play will retain all this charm, and the intelligent, sympathetic listener will be able to create on the stage of his own imagination the setting for the story.

Mr. Arliss is of the opinion that, to get across to an audience, an actor must be seen, not merely heard. He does not look forward to successful professional actors ever becoming "radio stars" beloved by thousands of far away fans. Continues Mr. Arliss:

I doubt if, over the radio, there will ever be enough difference between the thousand-dollar-a-week man and the hundred-dollar-a-week man to attract the successful actors to the radio "stage."

Until some way is devised of making the radio play a profitable commercial proposition, I think it will be always a Little Theatre movement. Perhaps, if a great company were formed, with the finest actors, the best plays with which to work, and only those could listen in who have that company's machine, the radio play would take the same place as the motion picture or the theatre. But on the whole, I am inclined to believe that the radio play will be for the small, uncommercial theatre group. That will not prevent it from becoming a great art, however.

Neither the radio nor the moving picture can ever take the place of the theatre. The Theatre is the only complete art. But of the two, the radio play will be most satisfying to those who love the drama for its literature. Neither the radio play nor the moving picture play will ever hurt the real theatre; rather, I think, they will go hand in hand. The radio and the moving picture will stimulate the interest and appreciation of the public in the possibilities of the theatre itself.

Communications

Mr. John Wallace,
RADIO BROADCAST,
Garden City, New York.

SIR:

I have been interested in your "Listeners Point of View" columns, and in the February issue, I noted "Readings in Foreign Languages." The other evening while looking up a German word in the dictionary and listening to some station who was broadcasting in a foreign language it suddenly occurred to me to get a dictionary of that language, pick out some word used frequently and hear just how it was pronounced. The result was startling and I picked out several more with equal satisfaction. And now when I see those words I can pronounce them quite easily. If that linguist would tell his listeners what he was going to read on a certain night and hour from a certain station we could get the article and follow his reading and gain a great deal more than in any other way, even if we didn't understand any of it at first.

J. C. FINNEY,
Nashotah, Wisconsin.

Mr. John Wallace,
RADIO BROADCAST,
Garden City, New York.

SIR:

I often wonder why the broadcasting stations so seldom furnish harp music. The harp always broadcasts its music well, and its tones are so sweet and pleasing that it cannot but be a great favorite with most everybody. Probably the greatest radio treat I ever had was when, about a year ago, a harp ensemble of forty harps was broadcast from New York by one of the best stations. We have plenty of saxophone, harmonica and "old time fiddle" music, but the harp, the grandest of all musical instruments, seems to have been put upon the shelf. Can't we persuade some of our accommodating program directors to take it down, dust it off, and hunt up someone who can tickle the strings occasionally. Then I'll be ha-a-a-a-a-ap-py!

H. G. Reading.
Franklin, Pennsylvania.

Mr. John Wallace,
RADIO BROADCAST,
Garden City, New York.

SIR:

Why wouldn't it be a good idea to let us have some folk songs once in a while, oftener, if possible? Gee, with that ancient and honorable name of yours, I'd be strong for the "hundred pipers and a' and a'" and all the rest of the Scottish songs, reels and strathspeys. These, to my way of thinking, contain the very soul of music.

What is more inspiring than "The Cock o' th' North," more tender than "A Pretty Girl Milking Her Cow" (Irish) and for sheer loveliness try and equal "Annie Laurie."

COLIN F. MORRISON.
Wayne, Michigan.

Broadcast Miscellany

THE versatile Graham McNamee of WEAF's staff added no little interest to our nightly ear work, some time ago, when he read a group of verses, among them Gray's "Elegy" and Kipling's "Boots," to a decidedly rousing musical accompaniment. We learned later of at least four bridge games he broke up with his impassioned and hypnotizing recital of the mad "Boots."

KFNF at Shenandoah, Iowa, we were informed by certain publicity material, broadcast for thirty consecutive hours on its birthday. Yours for larger and longer days! When, with the millennium, comes the forty hour day, we shall utilize the extra sixteen hours for lying in bed of a morning.

ARRANGEMENTS are being made, we are told by KOA, whereby all important athletic matches and contests throughout the country will be relayed to Denver by a network of leased wires and flashed over the microphones. To what extent they will be handled in detail or play-by-play, however, will depend on the nature and general interest of the attraction, it was said. In the case of golf, tennis, and other tournaments, it was expected that a summary of final returns would be sufficient.

WE DID not hear "The Miracle" as broadcast by WGBS during the New York run of the spectacle, but have just recently heard it broadcast from the Auditorium theater in Chicago by WGN, and tender it sundry palms as one of the best things of the year. Of course the success of the broadcast was mostly due to the enormous appeal of the play itself, but a none the less large share of praise must go to the radio technicians who made possible its aërial presentation with so little diminution of effectiveness. "The Miracle" being preëminently a spectacle and feast for the eye would seem, off hand, to be poor material for the radio. But its story is of such simple dramatic effectiveness that it lost nothing in the telling by Bill Hays, the WGN announcer. And the colorful music, the chanting, the hymns, and the roars, shouts, and cries of the 600 or more persons who took part in the production were ably transmitted, which, we opine, was no mean engineering feat.

THE "Eveready Hour" heard through WEAF, WEEI, WFI, WCAE, WGR, WWJ, WOC, KSD, WJAR, WCCO, WTAG, WGN, WEAR, and WSAI at 9:00 o'clock (E. S. T.) each Tuesday evening we have come to count among the pleasantest of radio's offerings. For instance there was the program of old time "Sob Ballads" of thirty years ago. The interpretation of these heart-renderers by the Eveready artists was in delightful burlesque fashion. Among the songs were such as: "Break the News to Mother," "After the Ball", "The Picture Turned Toward the Wall" and "The Bird in the Gilded Cage."

ARRANGEMENTS have been made by WRC, at Washington, to broadcast week by week the adventures and experiences in the African Jungle of the exploring party headed by Dr. William M. Mann, director of the National Zoölogical Park, which set out last month under the auspices of the Smithsonian Institution, in coöperation with Walter P. Chrysler, automobile manufacturer.

The accounts of the adventures will be contained in letters written by Dr. Mann to the radio audience of WRC, and rushed to the United States from the interior of the African wilds. They will be read in connection with the "Zoo Talks" and broadcast under the direction of Doctor Mann, and Austin H. Clark, of the Smithsonian Institution, during the past year.

Doctor Mann is an explorer of international fame, having been associated with many of the greatest scientific expeditions in Central and South America. In 1914 he visited Egypt, the Sinai Peninsula, Palestine and Arabia with Dr. John C. Phillips, collecting specimens of mammals and birds. Later he was in charge of the Mulford expedition to the Amazon Valley and across South America to collect and study plants used in the manufacture of drugs and to make zoölogical collections.

A year ago Doctor Mann began the radio presentation of weekly notes of interest from the National Zoo and discussions on the habits and idiosyncrasies of the animals, most of which are very familiar to the residents of Washington and visitors to the Capital City.

THE dance tunes of other years are being revived successfully on the air by William Spencer Tupman's Hotel Mayflower Orchestra through WRC. In each of the Tuesday Night "Melody Hours," played by the orchestra for the radio audience, three of the most popular dance tunes of the last fifteen years are presented without announcement of titles. Weekly prizes for naming the numbers are offered. The "Melody Hours" are broadcast from 10:30 to 11:30, E. S. T., every Tuesday night from the Mayflower Gardens of the Mayflower Hotel.

CHICAGO has all too few "indirect advertising" programs—which is unfortunate, as programs of such origin form the very backbone of radio entertainment. There is, however, the "Federal Master Artists Series" broadcast each Friday evening at 9:00 through KYW. This series is financed by the Federal Electric Company and prominent among its offerings have been two concerts by the Jacques Gordon String Quartet, an able organization whose members are recruited from the Chicago Symphony Orchestra.

THE following yarn has been wandering about in the public prints. It has long been divested of any evidence of parentship or authorhood, so we, in turn, will "steal" it. It has to do with a housewife, inexperienced at dial twisting, who attempted to tune-in a cooking lesson program with this startling result:

Hands on hips, place one cup of flour on the shoulder, raise knee, depress toes, and wash thoroughly in one half cup of milk. In four counts, raise and lower left foot and mash two hard-boiled eggs through a sieve. Repeat six times, inhale one-half teaspoon salt, one teaspoon baking powder, and one cup of flour. Then breathing naturally, exhale and sift. Attention. Jump to a squatting position of quick time. Twist sideways and forward right and left as far as possible and beat egg swiftly and briskly, arms forward over head. Raise the cooked egg with the flour and in four counts make a stiff dry dough, which is stretched at the waist. Thighs flexed, lay flat on the floor and roll into marbles the size of a walnut. Hop to a straddle in boiling water but do not boil at a gallon. After ten minutes remove and wipe with a rough towel and serve with fish soup.

THE effort of the officials of the Bakelite Corporation and station WJZ to determine the makeup of the Bakelite hour by a series of four test programs resulted in a tied vote. The four types of program submitted for approval were: 1. Concert artists assisted by a small orchestra; 2. Grand opera; 3. a varied program of classical and semi-classical selections by mixed instrumental and vocal soloists; 4. Chamber music concert. The first three named received an equal number of votes. So at present the Bakelite hour is being varied each Sunday. A set type of program will, however, eventually be selected from the three.

WHETHER the various "Music Festivals" being held at this time of the year in various parts of the country are being broadcast we can not, at present writing, foretell. We know that definite plans have been made by KOA to broadcast Denver's far-famed Music week celebration and annual spring festival. And efforts are being made to arrange for the broadcasting of the North Shore Music Festival at Evanston, Illinois. If the many similar "festivals" of equal or lesser importance throughout the country are tapped by radio, as they should be, the last two weeks of May and the first two weeks of June will come to be the most musical period in the year's radio offering.

JAZZMANIA" a radio play by Dailey Paskman, director of WGBS, has proved one of the best novelties offered by that station. It is in the form of a dramatic and musical fantasy. Jimmy Kemper, of vaudeville fame, is co-author and takes the principal rôle. Mr. Paskman (who collaborated with Rudolf Friml on "Chansonette," a recent song hit), composed a number of original lyrics specially for "Jazzmania." Another repetition of the fantasy seems likely and is worth watching for.

THE prominent vaudeville singers, Van and Schenck, are among the latest recruits to the ranks of broadcasting artists. They are appearing three times a week before the microphones of WMCA.

IN ORDER that those who live in the Metropolitan area may know something about current theatrical conditions in other cities of the United States, Oliver Sayler, well known critic, who has been a regular feature at WGBS ever since the station has been operating, has left New York on a tour of the country. Each week Mr. Saylor will report by wire on plays on the road, this report to be read at the regular time for his "Footlight and Lamplight" series —every Thursday evening at 8:30.

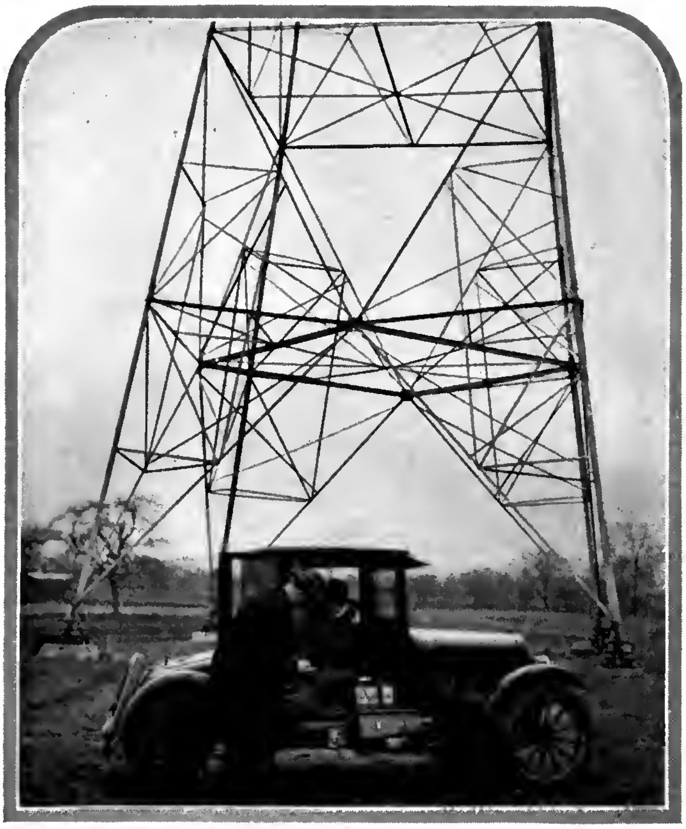
THE WEAF SHAKESPERIAN PLAYERS

Who have been heard, to the tune of much favorable comment, through WEAF every Saturday evening at 8:15 in tabloid presentations of Shakespeare. Back row, left to right: Geral Stopp, Katherine Emmet, Laurence Cecil. First row: Alfred Shirley, Margot Lester, and Charles Webster

Cutting Out the Locals

Results of Actual Field Tests With Wave Traps on a High Power Station—The Second of Two Articles Showing How Receivers Can Be Made More Selective—How to Build a Radio-Frequency Amplifier and Adapt it to Your Receiver—High Power Broadcasters Need Not Cause Interference

By HOWARD E. RHODES



UNDER THE SHADOW—WJZ'S TOWERS

Making interference tests under the great towers of station WJZ at Bound Brook, New Jersey. Shielded receivers and other radio sets which were really selective could tune out the station even at this location

IN A series of articles concerned with interference from local stations there is naturally forced into the discussion the question of super-power (so-called) and its effect on local reception. This question has received a great deal of publicity lately in the press and in radio publications. In RADIO BROADCAST, not many moons ago, Carl Dreher, writer of "As the Broadcaster Sees It" took up the cudgel for super-power; and stated the case in this wise: "Everybody is increasing power who has the money, because it is the next sound technical step." We are not going to discuss the theoretical points that enter into a consideration of high power; but are going to confine ourselves to the practical results of super-power. For, concludes Mr. Dreher, "After all, we can talk ourselves dry and in the end the issue will be decided by performance."

It is generally agreed that high-power stations should be located in the country as far from any town as is conveniently possible, so as to reduce to a minimum the number of persons affected. The field strength of a high frequency wave bears an inverse relation to the distance from the source (neglecting the effects of various kinds of absorption) so that the field strength rapidly decreases within a comparatively small area around the transmitter.

It is quite evident then, that if the transmitter is located in the country, the amount of trouble it causes will be comparatively small and the only persons who will be seriously affected by it are those living within one or two miles of the transmitter. Beyond this distance, the signal strength has decreased to a point where it is a very simple matter to eliminate it with any selective receiver. It is, therefore, only within this comparatively small area that any special arrangements must be used to eliminate the signal.

RADIO BROADCAST felt the need of obtaining some actual data on high power and its effect on reception, so a series of experiments were undertaken, designed to show whether it is possible to cut out interference when the receiver is located a comparatively short distance, say one or two miles, from the interfering transmitter.

The field tests by the technical staff of RADIO BROADCAST were made at a point about $1\frac{1}{2}$ miles from the transmitter of WJZ located near Bound Brook, New Jersey. This station has a capacity of 40,000 watts, and during our tests was presumably operating on full power.

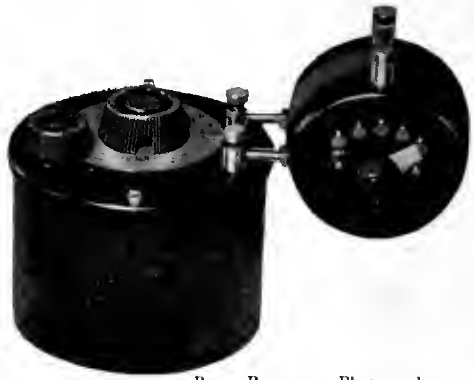
There were two major points to be determined:

1. How successfully could the signal be eliminated?
2. Did the high powered signals have any blanketing effect on the signals from other stations?

HOW THE "HIGH-POWER" TESTS WERE MADE

THE tests were made on an ordinary four-tube unreflexed Roberts receiver and in order to eliminate WJZ, a wave trap was used. There was nothing unusual about the receiver and it was operating on an antenna having a horizontal run of about 50 feet and a lead-in of about 30 feet. The open end of the antenna was pointing toward the station, which was an advantage over having the closed end point toward the source of interference, since reception is notably poorer in the direction of the open end.

In the first place, a resonance curve was taken on a wave trap. The trap used was a General Radio instrument and is shown in Fig. 2. Many other commercially available types are equally satisfactory. The resonance curve was taken using an audibility meter. The curve, therefore, does not represent any electrical quantities but is actually a direct indication of the audibility of the signal. From the curve it is evident that within 20 kilocycles the audibility decreases to about 10 per cent. of the original value, indicating that the band of frequencies neutralized by the trap only extended about 20 kilocycles on either side of resonance. In order to obtain this curve it was found necessary to use the trap conductively coupled, with the entire coil of the wave trap in the antenna circuit as shown in Fig. 4. Taps are provided for use when the trap is inductively coupled to the antenna, but if so connected, it was found impossible to eliminate the signal. The same test was



RADIO BROADCAST Photograph

FIG. 2

A wave trap manufactured by the General Radio Company. This unit is not only useful as a trap but is also an excellent wavemeter

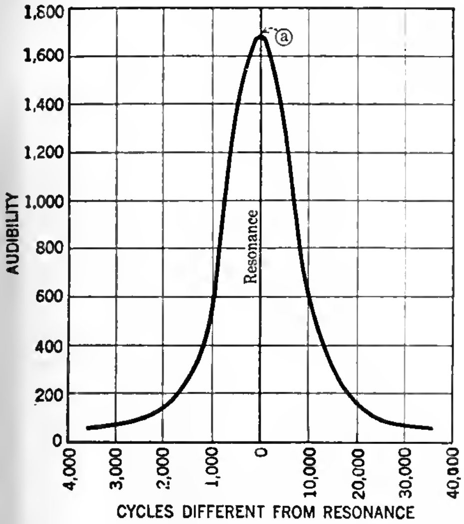


FIG. 3

An audibility curve showing how the strength of an interfering signal is decreased by the use of a wave trap

made with several other traps including the Accuratune, made by the Mydar Radio Company, and the Filtrola, manufactured by the All-American Radio Corporation.

The major reason for using the General Radio instrument in taking the data contained in this article was that it uses a calibrated condenser, which was essential in making these measurements. After the tests with the General Radio and other wave traps mentioned above, a home made trap was tried and results were quite satisfactory in every way. A home made unit, very easy to build, is illustrated in Fig. 8.

It is supposed by some that a high power station would have a blanketing effect on reception in the vicinity in that the existence of very strong signals in the ether would in some way or other neutralize the signals from other stations so as to make their reception very difficult. In our tests no such effects could be noticed. WOR, separated from WJZ by approximately 80 kilocycles, could easily be tuned-in without any interference. Broadcasting from a Philadelphia station located 60 times as far away as WJZ, and having only 1 per cent. of the power could be tuned-in without difficulty.

BLANKETING AND INTERFERENCE ISN'T NECESSARY WITH HIGH-POWER

THESE tests, we believe, show quite conclusively that a high power station need not cause excessive interference. A certain amount of co-operation between the company operating the station and the public is, doubtless, necessary, and it seems logical that the operating company should take cognizance of the interference which has been created by the operation of their station and do whatever they can to help in the way of supplying information, investigating complaints, etc.

There are several factors contributing to the opposition to high-power. One of these is the fact that broadcasting started on low power. Low power meant two things, first, that very sensitive receivers were necessary in order to obtain reception if the receiving point was located at any distance from the transmitter; and secondly interference from near-by stations was not serious except in a very restricted area quite close to the station. The result was that many receivers were made with no means of eliminating local interference. Consequently, the advent of high power caused many listeners to raise a loud cry of protest because of the interference produced, while many others immediately settled down to the problem of its elimination and constructed wave traps. Opposition from these individuals soon disappeared and the only objectors left were those, who, with no acquaintance with radio, felt that the interference could not be eliminated. So we had letters to newspapers, petitions to Congress, and a general rumpus all out of proportion to the importance of the question. There was talk of blanketing effect of high power and so on. At the beginning a lot of us got excited and no one did anything.

RADIO BROADCAST Photograph

APPLYING A WAVE TRAP PRACTICALLY

A wave trap in a home in Bound Brook, New Jersey, attached to a five-tube, one-control set is successful in tuning out WJZ not a mile away. The photograph was taken when one of the staff of RADIO BROADCAST Laboratory visited Bound Brook to test the operation of wave traps in a locality where they are needed

After the noise somewhat subsided it became evident that the problem and its solution was not as serious as was first thought. The excitable souls found out that by the use of simple wave traps they could do what some very sensitive receivers seemed unable to do. And so, with the installation of this simple device, a great deal of the agitation subsided.

In the vicinity of New York, most of the complaints were lodged against WJZ. If this station had opened on some hot summer night, when the static was strong it would have been welcomed with open arms by many of its now bitter opponents. We should realize the advantage of being located near a powerful broadcaster, for it is the one thing that will make summer reception at all pleasant. Now there is only one good way to get rid of static and that is to have enough signal energy coming down

RADIO BROADCAST Photograph

DIRECT HELP FOR THE LISTENER

B. S. McCutcheon showing a Bound Brook resident how to use a wave trap successfully. Mr. McCutcheon's job is to investigate every letter of complaint by visiting the home of the complainant and studying the situation. He has been able to help the listener-in in 90 per cent. of the 900 cases he has investigated

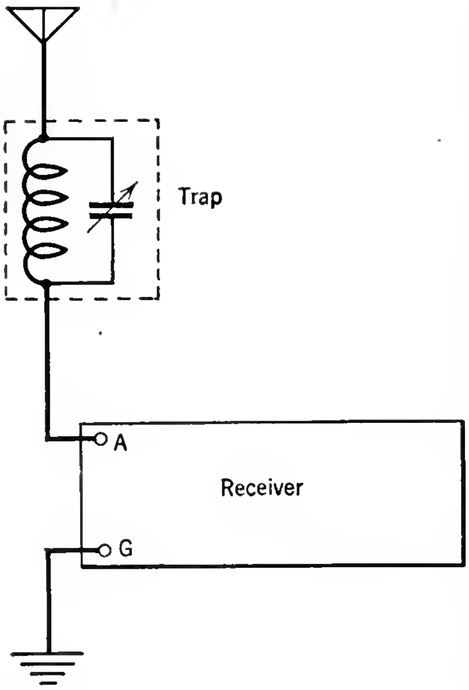


FIG. 4
How the wave trap was connected to obtain the curve in Fig. 3

through the antenna completely to drown out any noise.

These remarks concerning high-power were brought about by a consideration of the problem at hand; the elimination of interference. The first article of this series appeared in the April RADIO BROADCAST and described the construction and operation of wave traps, such as were used in the Bound Brook tests.

HOW TO ATTAIN SELECTIVITY AND INCREASED SENSITIVITY

HOWEVER, a wave trap merely functions to increase selectivity and it is evident that it would be somewhat better not only to increase the selectivity but also at the same time to increase the sensitivity of the receiver. This would make it possible to cut out the interfering signals and also to receive signals from more distant stations. We shall now describe a unit which will accomplish these two things. It should first be clear as to what is meant by selectivity and sensitivity.

The selectivity of a receiver is a measure of its efficiency as a filter of electrical waves. In other words, the whole idea of "tuning" is so to adjust the electrical characteristics of the tuning elements to reject all frequencies except the desired one. The completeness with which undesired frequencies are eliminated depends upon the resistance of the tuned circuit. The lower this resistance is the better will be the selectivity.

The perfect filter for a broadcast receiver would have a characteristic like that of Fig. 5 which represents an ideal band-pass filter. It should be noted that the sides are vertical so that all frequencies outside of the band *a-b* are completely attenuated. Practically, with the single radio tuned circuit it is not possible to obtain a filter with such a frequency characteristic. Fig. 6 shows how an actual unit differs from the hypothetical case of Fig. 5. With a low resistance circuit, a curve like A is obtained; if the resistance is made ten times as large, the characteristic changes to that of curve B. In taking these curves, the input voltage was constant so that the ratio of the currents at frequency *f* indicates considerable decrease in efficiency caused by high resistance units. Hence the importance of well designed low resistance circuits.

Now, if the receiver is to be selective, it must have a sharp resonance curve — but not too sharp—for, from the point of view of exact quality, a very high degree of selectivity must not be attained, since that does not permit the equal transmission of all the side bands of the carrier wave which carries the voice frequencies. Fulfilling this one and only requirement for selectivity—namely, that the resonance curve of the receiver be sufficiently sharp—has nothing to do with sensitivity.

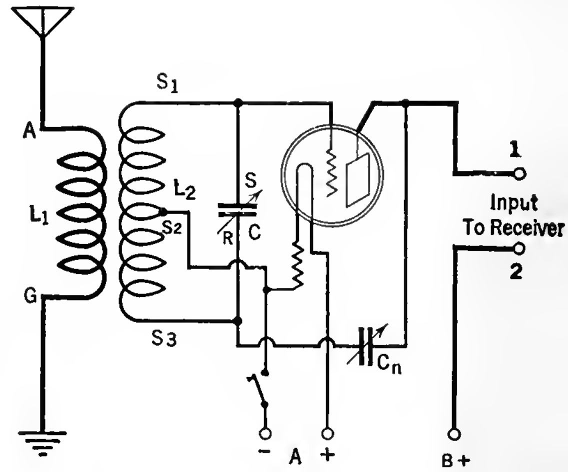


FIG. 7
A diagram of a radio-frequency amplifier which will increase the efficiency of many receivers

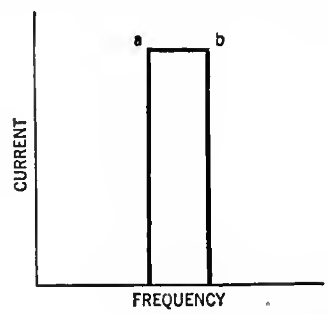


FIG. 5
An ideal resonance curve for a radio receiver

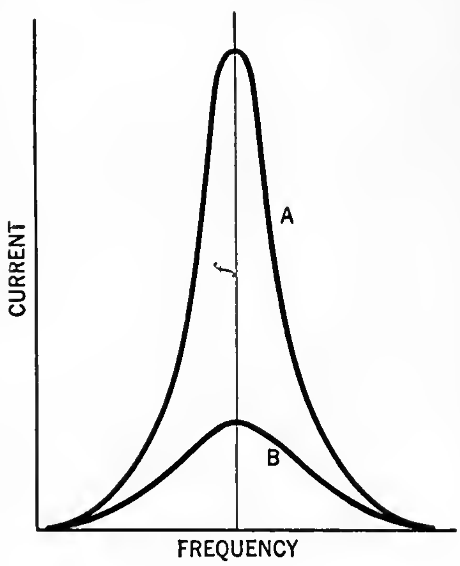


FIG. 6
The reason for the use of low loss circuits. Curve A is obtained from a low resistance tuned circuit, and curve B from another circuit with ten times as much resistance

As selectivity was a measure of the receiver's efficiency as a filter, so sensitivity is a measure of its efficiency in the amplification and detection of radio frequency energy. A receiver using several stages of tuned radio frequency is an example of sensitivity obtained by use of amplification and the regenerative detector is an excellent example of sensitivity through the use of an efficiency detector circuit. The radio-frequency amplification of a receiver is the ratio of the voltage on the grid of the detector to the voltage picked up by the antenna and it is this ratio that determines the sensitivity.

ADDING A RADIO-FREQUENCY AMPLIFIER

THERE is a comparatively simple method whereby both the selectivity and sensitivity can be increased at the same time, which involves the use of an additional stage of tuned radio-frequency amplification. This can easily be accomplished in connection with practically any type of receiver in use so that it affords an excellent method of increasing the efficiency of a receiver.

An excellent manufactured radio-frequency unit designed for use in this manner is the Penetrola, made by the Walbert Manufacturing Company of Chicago. It is possible to connect this unit to a receiver without any changes whatsoever. The Penetrola is illustrated in Fig. 13.

A home-made radio-frequency unit adapted for use in this connection is shown in Fig. 7. This design proved to be excellent from the standpoint of adaptability to existing receivers with a minimum number of changes. The completed unit is shown in Figs. 8 and 9. It was constructed in the Laboratory.

The following notes are given for those wishing to duplicate the RADIO BROADCAST model.

The parts used in the model are as follows:

L_1, L_2,—General Radio Coil, Type 277 D
C—Cardwell .0005-mfd condenser.
Cn—Hammarlund midget condenser

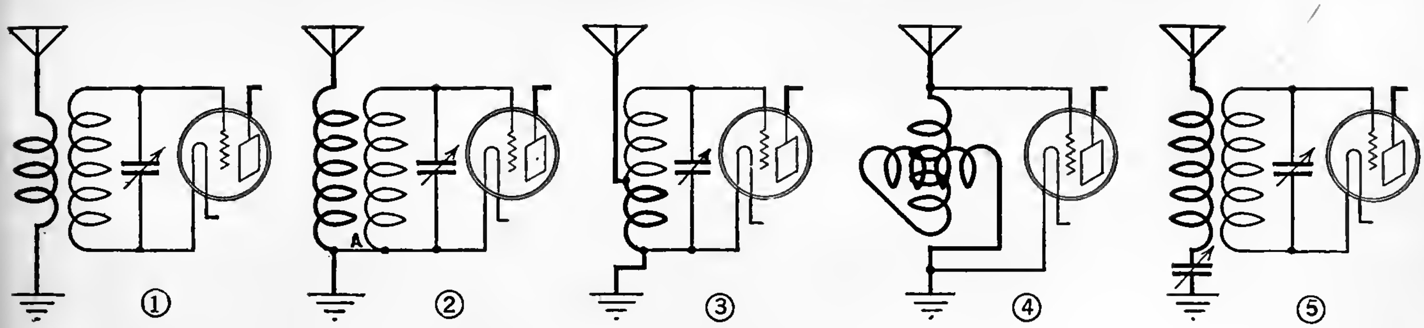


FIG. 8

One of the diagrams in this Figure is the type of antenna connection used in your receiver. The diagram Fig. 11 shows the adaptation necessary to include an r. f. amplifier-wave trap.

1—Amsco socket
Miscellaneous parts, wire, screws, binding posts, etc.
1 panel and cabinet 7"x 8"
1 Rathbun dial
1 Filament switch

The apparatus listed above need not necessarily be used. Any standard parts will give entirely satisfactory operation.

Those wishing to construct a home made coil should adhere to the following specifications:

- L L—60 turn coil of No. 22 wire on a $2\frac{1}{2}$-inch tube. Tap the coil at the 21st turn from the filament end.
- L_1—15 turn coil of No. 22 wire wound over the filament end of the secondary.

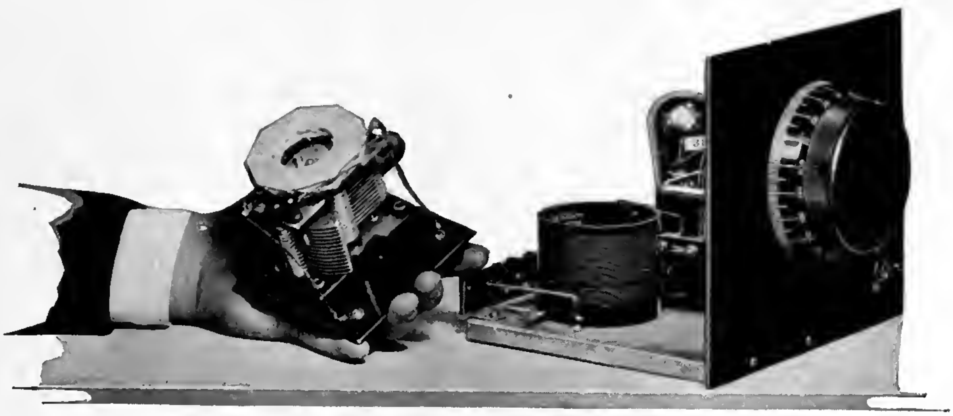
APPLYING THE UNIT TO YOUR RECEIVER

THE location of the various parts is shown clearly in Fig. 12 and no difficulty should be had with regard to the placement of units. If duplicate parts are purchased, the panel layout of Fig. 12 can be used.

In wiring the unit, make all leads to the grid and plate as short as possible, otherwise it is apt to be difficult to control spurious oscillations. The actual circuit is very simple and no other special instructions need be given. In order to adapt the receiver to the unit, some slight change is necessary.

The antenna system of a receiver is usually connected by one of the methods illustrated in Fig. 8. In Fig. 11, we have revised these circuits so as to indicate what changes are necessary in order to attach the radio frequency amplifier. Readers should determine what type of antenna circuit is used in their receiver and then locate it in Fig. 8. The numeral preceding the notes given below refers to Fig. 8 so that the notes concerned with any of the circuits can readily be found.

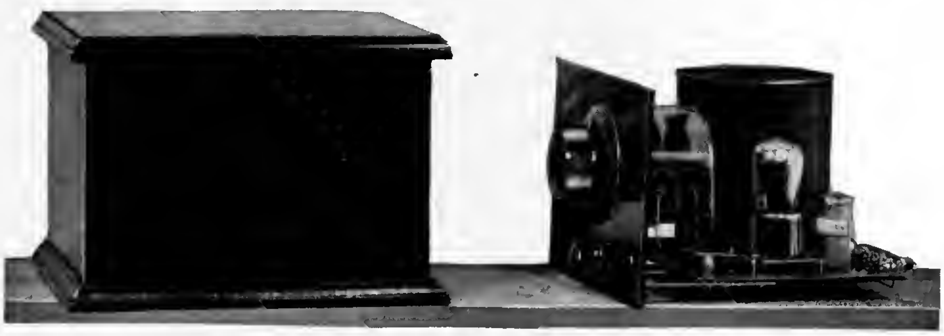
(1) This is the simplest receiver to which to attach the r. f. amplifier—Disconnect the antenna and connect the antenna terminal of the set to terminal No. 1 of the amplifier. Then remove the ground terminal to binding post No. 2. If an antenna series condenser is used (indicated by dotted lines in the



Radio Broadcast Photograph

FIG. 9

The left-hand picture shows a home made wave trap that can be used to eliminate interference. The right-hand picture shows a model of a radio-frequency amplifier



Radio Broadcast Photograph

FIG. 10

The "Penetrola," a completely enclosed radio-frequency amplifier, which will greatly increase the sensitivity and selectivity of a receiver

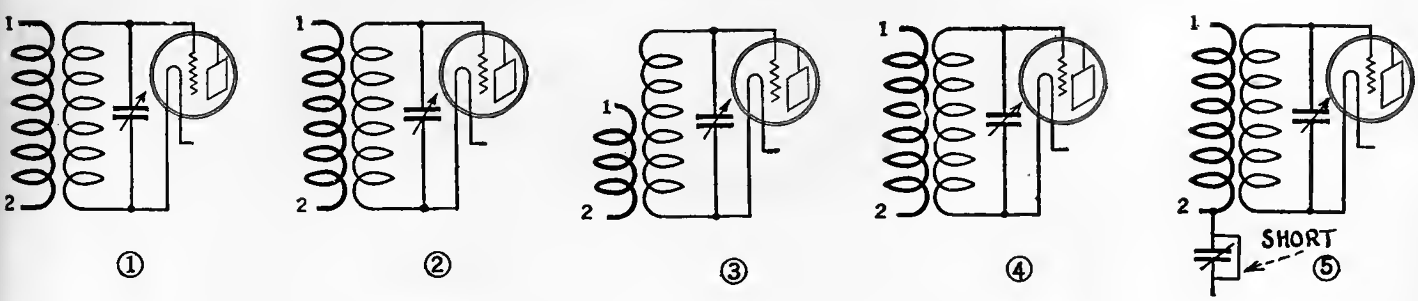


FIG. 11

The circuits of Fig. 10 revised so as to permit the use of a radio-frequency amplifier

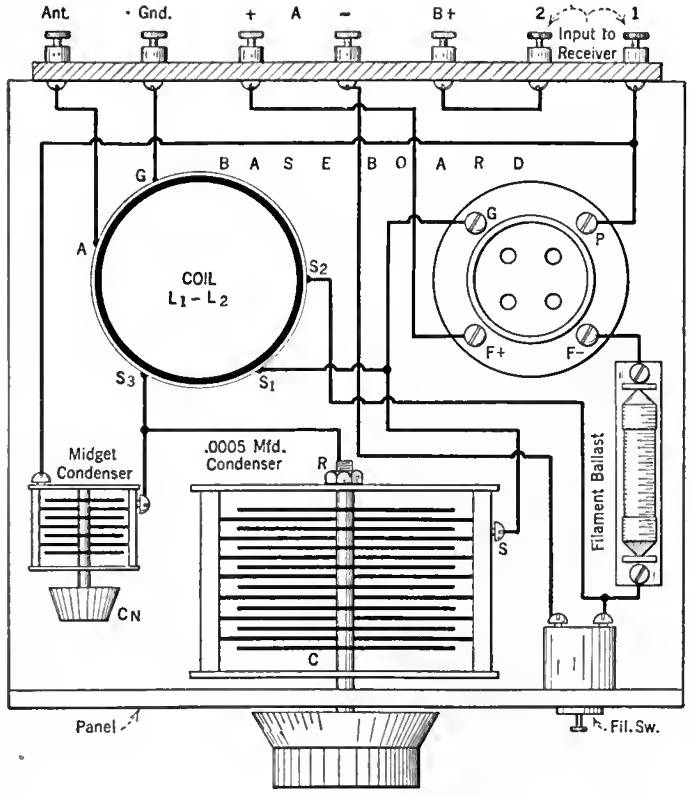


FIG. 12
Apparatus layout of the radio-frequency amplifier Refer to Fig. 7 for the schematic diagram of this unit

drawing) the connection to terminal No. 1 should be made from the side of the condenser which connects to the coil.

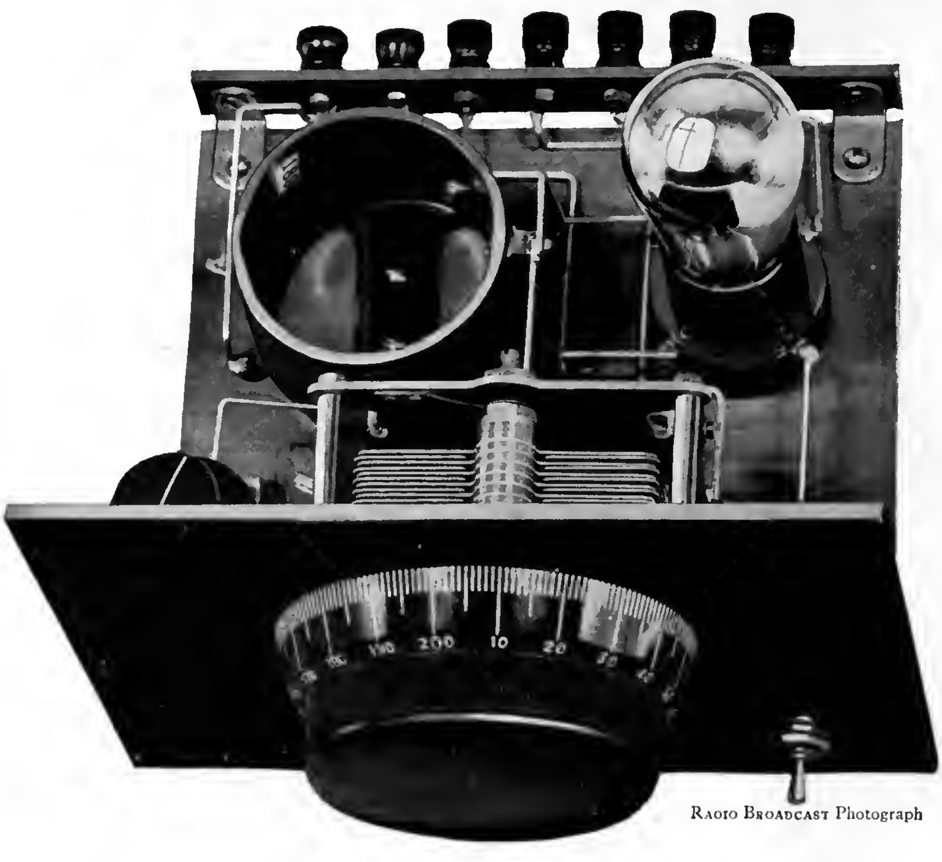
(2) This circuit is practically the same as No. 1 with the exception that there is a connection between the antenna coil and the secondary winding marked "a" on the diagram. This connection should be removed and then the circuit is a duplicate of No. 1. This connection must be removed in order to prevent short-circuiting the B battery.

(3) In order to adapt this circuit to the new unit, it is necessary to add a new winding to the antenna coil. This winding should consist of 15 turns of No. 22 wire wound over the filament end of the secondary winding. One end of the coil would then be connected to terminal No. 1 and the other end to terminal No. 2. The antenna connection is of course removed from the secondary coil.

(4) Practically the only method of adapting the circuit to the amplifier is by removing the variometer and substituting in its place a coil of the same type as in the former circuits. Revised, it appears as in No. 4 Fig. 11.

(5) This circuit is very easily changed over. Connect terminal No. 1 to the antenna terminal on the receiver. Terminal No. 2 should connect to the other end of the antenna coil. An optional method is illustrated in Fig. 11 where the antenna tuning condenser C has been shunted and connection made directly to the ground terminal.

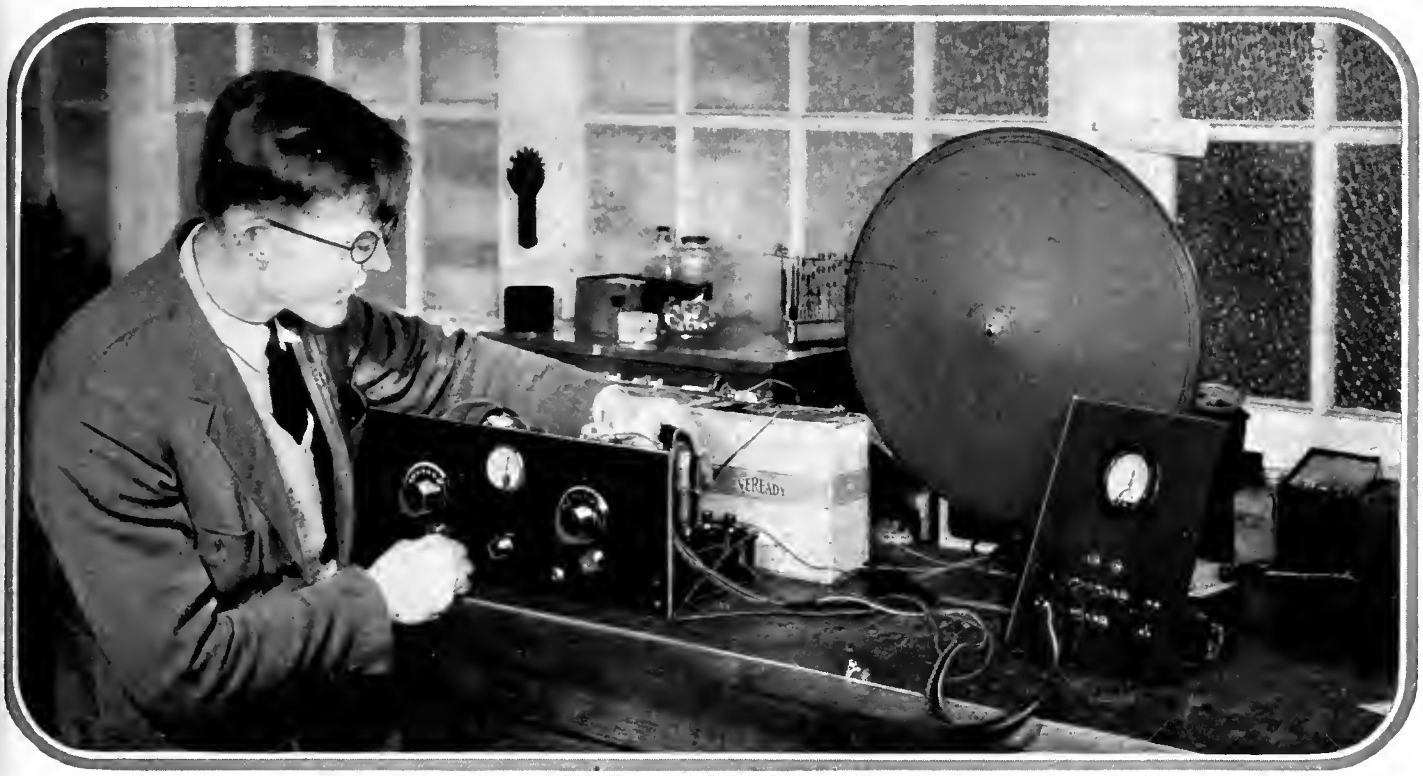
After the necessary changes have been made, the batteries can be connected. Remove all the tubes before this is done so as to prevent damage in case an error has been made. When you are sure everything is correct, the battery terminals on the new amplifier unit should be connected to the corresponding terminals on the receiver. Finally, the antenna and ground should be connected to the correct binding posts. The receiver and amplifier can now be turned on and the set operated in a normal fashion. The Rathbun dial will cause the straight-line capacity condenser to tune as though it were a straight-line frequency unit so that all stations will be evenly separated over the entire 200 degrees of the dial.



Radio Broadcast Photograph

FIG. 13
Another photograph of the amplifier illustrated in Fig. 8

A Simple Set Tester for the Home Laboratory



THE TESTER IS HERE SHOWN IN USE IN THE "RADIO BROADCAST" LABORATORY

An Easily Constructed and Inexpensive Tester for the Home Experimenter Which Should Simplify Testing of Circuits and Receivers—Its Construction, Operation, and Applications

By SID GOODWIN

Radio Editor, Portland, Oregon, "Telegram"

THE job of trouble shooting in any piece of radio apparatus is not at all pleasant, but after the novelty of building receiver after receiver has worn off, the home constructor will find that the addition to his equipment of a simple trouble shooting device will be well worth a few hours spent in constructing it.

Besides preventing a ruffled temper, this unit expedites the matter of locating trouble in radio receivers by means of several throw-over switches and a triple-scale voltmeter. Parts that are defective may be located quite easily and new parts, before being placed in a receiver, may be tested to determine whether or not there are any defects in the manufacture.

Usually when a receiver will not work, the constructor first checks his wiring and then after that inspects each individual piece of apparatus employed in the assembly. Much depends in such a test upon the individual's experience and intelligence to know where and what to look for. To build the trouble shooter described here requires no special effort on the part of the constructor except that he be able to understand the simple wiring and assembly of the instrument itself. Merely by placing a prepared plug in the socket of a receiver from which one of the tubes has been removed it is possibe to note the action of the various circuits by flipping the switches on the front of the trouble shooter panel.

What The Tester Will Do

1. Show an open grid circuit.
2. Show an open plate circuit.
3. Indicate the voltage applied to each tube filament.
4. Indicate the plate voltage for each tube of a receiver.
5. Test fixed and variable condensers for short circuits.
6. Test coils for open circuits.
7. Test audio transformers for open circuits.
8. Test phones and loud speakers for open circuits—and in so doing, will guide you in locating the faults in your radio receiver.

In this way it may be determined whether or not the grid circuit is open, whether or not the plate circuit is open, or it may be observed whether the B battery applied to the socket is of incorrect polarity. Filament voltage may be determined and polarities of the various batteries indicated. Once an incorrect reading is obtained, it is plain that trouble exists in that part of the circuit in which the switches are connected.

The plug, to which is attached four flexible leads, each about four feet long, may be made from parts found in the junk box. A round piece of wood of the diameter of the tube socket shell may be smoothed over with sand paper; machine screws fastened in the base and holes drilled from the top down to the tops of the screws are enough to make connection to the leads. Or better yet, if an old tube is handy, the glass may be broken away and removed entirely from the shell and the leads soldered to the prongs on the inside of the shell. A wooden plug to fit inside the shell may be prepared to serve as a handle. A socket adapter will serve the purpose of a plug admirably. The leads attached to the prongs may be led up through a central hole bored in the wooden handle part of the plug.

The voltmeter employed in the trouble shooter constructed in Radio Broadcast Laboratory is a Jewell, triple range, No. 88160, type 55, having three scales as follows: 0-8 volts, 0-80 volts, 0-160 volts. That employed in the model constructed by the author is also a triple range type as follows 0-7.5 volts, 0-30 volts, 0-120 volts. The former is undoubtedly better since it allows readings of voltages in excess of 135 which is often used in audio amplifier circuits.

Two anti-capacity switches of the type manufactured by the Federal Company, bearing the number 1424W, are satisfactory as the controls which are operated from the panel front to connect the meter into the various parts of the circuit under test.

Six pin jacks are arranged in hexagonal form, and another pin jack is placed at the center. These are for making connection with the flexible cords which lead to the test clips, and the specially prepared plug which fits into the socket of a radio receiver.

All these units are mounted on a panel 8 x 10 inches, which if desired, may be fastened to a box or base.

The materials required for the construction are as follows:

- 1 Panel 8 x 10 inches.
- 2 Anti-capacity switches (Federal No. 1424W).
- 7 Pin Jacks.
- 7 Terminal Pins.
- 1 Voltmeter. Triple scale (Jewell type 55 or 55-88160).
- 1 Plug constructed as described 28 feet flexible lead wire, bus bar, etc.

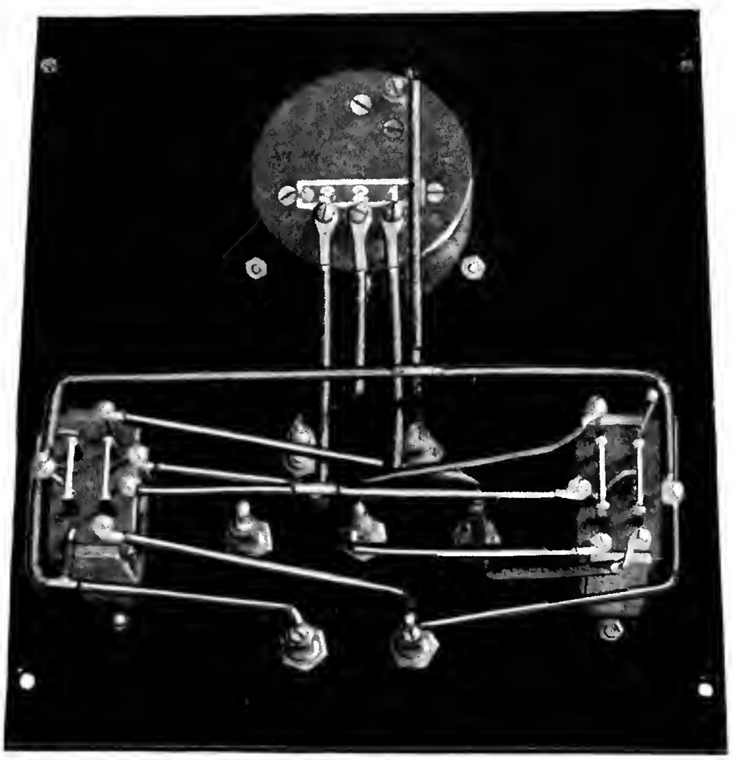
No panel layout is necessary since the position for the various parts may be changed to suit the fancy of the constructor. The several photographs will serve as a guide to those who wish to duplicate exactly the construction described here.

After the parts have been assembled and wired in accordance with the circuit diagram, Fig. 4, which, by the way, is a rear view of the trouble shooter, the device may be put into operation.

Radio Broadcast Photograph

FIG. 1

The front or panel view of the tester shows the placement of the switches, pin jacks and flip-switches. The panel size is 8" x 10". No panel layout is shown, as each constructor may approximate the layout shown above to conform with the parts he chooses to employ



Radio Broadcast Photograph

FIG. 2

A rear view of the tester discloses the fact that simple point-to-point connections make the wiring of the device not difficult, and easy to check

HOW TO OPERATE THE TESTER

THE two top pin jacks marked Test, minus and plus, are connected directly to the volt-meter so that a reading on the intermediate scale is obtained when a 45-volt block of B battery is added to the circuit in which is included the piece of apparatus under test. This is shown in Fig. 3. Where it is desired to test for continuity of circuit, a reading of the voltmeter will indicate a complete circuit. In case a condenser is to be tested then no reading is desired since the condenser itself presents an open circuit to the flow of direct current from the battery. By inserting a pair of phones in the circuit it may be noted whether or not the condenser is noisy or leaky.

The leads from the plug, are connected to their respective pin jacks, namely Grid, Plate, minus A and plus A. The pin jack marked B battery connects by the fifth flexible lead to the high voltage side of the B battery. Before inserting the plug in the socket of a radio receiver, the two anti-capacity switches should be in a neutral position. Then after the plug is inserted, pushing the lever of the left switch upward will produce a reading on the voltmeter which by means of its scale adjuster has been turned to the high scale reading. Such a condition indicates a continuous circuit for the grid circuit part of the tube circuit under test. When this same lever is pushed downward, the plate circuit is thrown into the meter circuit, and should there be no reading; obviously an "open" is present.

The switch at the right is for measuring A and B voltages. By shifting the position of the clip of the lead emanating from the B battery tip jack, the voltage of individual sections of the B batteries may be measured. It should be remembered that no voltage should be measured which is calculated or one suspects to be higher than the scale of the meter employed.

When filament voltage is

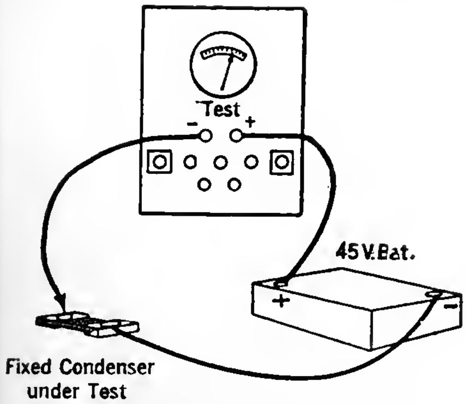


FIG. 3

A picture-diagram of the method employed to test condensers with the aid of the pin jacks labeled "test." Coils, transformers, phones, and numerous other radio articles may be tested in a similar fashion

measured it is possible that the meter will read backward. This may be corrected by reversing the position of the two leads terminating in the minus and plus A tip-jacks.

When the plug is inserted in the detector tube socket, no reading will occur when the left hand switch is tilted upward to read continuity of circuit for the grid circuit. This is because the grid condenser produces a virtual open circuit, and it is necessary to short it out with a clip or piece of wire to obtain a reading.

This trouble shooter will only indicate the circuit in which there is error. After this manifestation, it is necessary to conduct a minute inspection of that part of the circuit indicated by the test as defective actually to locate the source of trouble.

Considering that without such an instrument, the radio set builder must slowly check and inspect each part of a wired receiver, with the attendant possibilities of incorrect checking, the device described here is one that should grace the equipment cabinet of all dyed-in-the-wool experimenters because of its very evident time-saving qualities. The total cost of the tester should not exceed $20, and may run less if the constructor is able to use some parts he has already on hand.

Suppose that an actual test is to be made of the original two-tube Roberts receiver, which employs a stage of tuned neutralized radio frequency amplification and a regenerative detector whose output is reflexed through the first tube to be amplified at audio frequency. When the plug is inserted in the first socket and the switch on the front of the tester panel is thrown to the "Grid" position, it indicates, if a reading is obtained, that not only is the tuner secondary winding continuous but that the secondary of the audio reflex transformer is unbroken. Since the C battery in this part of the circuit is so connected that its voltage is added to that of the battery employed to obtain a multi-reading, it is obvious that at the same time an indication is obtained which will tell whether or not the C battery is in a top notch condition.

When the switch is thrown to the plate circuit, the continuity of the plate coil winding is manifest.

Inserting the test plug in the detector socket, the grid leak and condenser must be bridged by a clip or other connection to short it out of the circuit before a reading can be obtained for the grid circuit. In the plate circuit, the continuity of the circuit will be evident for both the tickler coil and the primary of the audio reflex transformer when a reading is obtained.

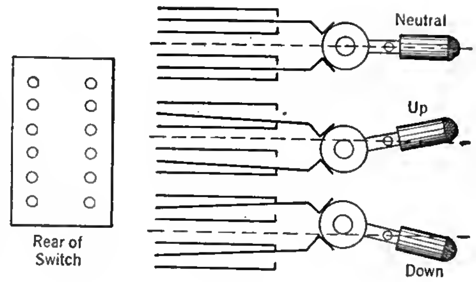


FIG. 5

The three positions which the flip-switches may assume. When the handle is pressed upward, the cam arrangement forces the blades downward into contact with the lower fixed blades of the switch and when pushed downward, the action is just the opposite. When the handle is in a horizontal position then no contact results.

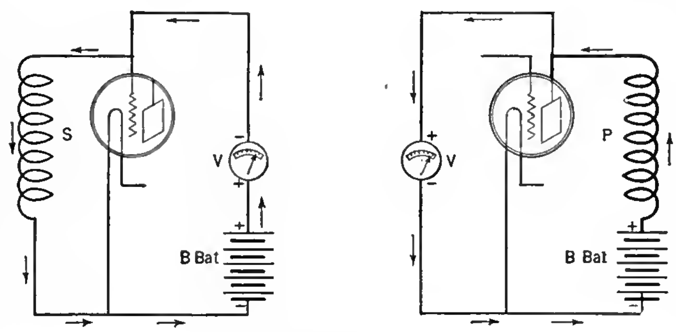


FIG. 6

Here at the left is how the circuit looks when the switch on the front of the panel is thrown to the "Grid" position. At the right the circuit indicates the connections when the same switch is thrown to the "plate" position. The A and B switch merely causes a reading of the voltage of either filament or plate batteries

A glance at Fig. 6 will show how the meter of the tester is thrown into the grid or plate circuit.

When the test terminals of the instrument are used, a pair of phones may be inserted in a series circuit, and an additional check will result where it is not always possible, because of the high resistance of some radio apparatus, to obtain a reading on the voltmeter. When the circuit under test is satisfactory, a click will be heard in the phones.

Another use for the test terminals is to determine the approximate resistances of various units by a voltage drop calculation. We will suppose that it is desired to determine the resistance of a large coil such as the secondary of an audio transformer. Several things must be known. First, by reading the voltmeter, determine the exact value of the voltage source in volts. Then determine the voltage when the unknown resistance is included in the circuit. With these values, the formula $R_X = \frac{R_V(E_B - E_V)}{E_V}$ may be invoked. Here R_X is the unknown resistance, R_V is the resistance of the voltmeter, which may usually be obtained from the manufacturer; E_B is the battery or source voltage; and E_V is the voltage reading on the voltmeter. An audio transformer will often seem satisfactory when tested for continuity although a short in its windings exists. A test of its resistance will, however, prove conclusive.

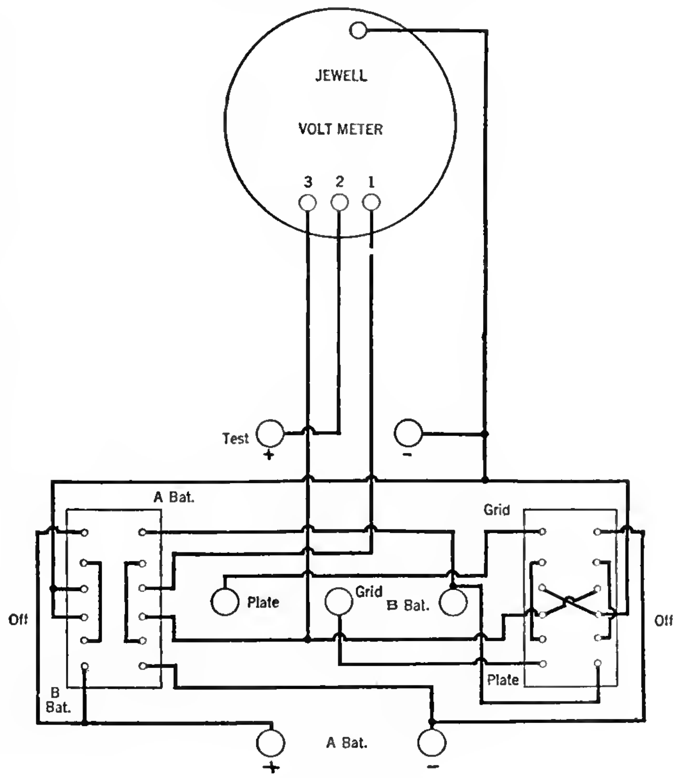


FIG. 4

The wiring diagram for the tester as viewed from the rear. Bus-bar, covered with spaghetti tubing, will make your tester look, as far as wiring is considered, like this circuit diagram, presenting a pleasing appearance

NEW APPARATUS

A Short Description of Some of the Radio Parts and Accessories Which Have Been Tested and Approved by the "Radio Broadcast" Laboratory

SCANNING the advertising pages of a popular radio magazine reminds us of our childhood days when, at Christmas, we gazed into the tinsel bedecked window, brightly illuminated, of the largest toy emporium on Main Street. We were amazed at the multiplicity of the goods offered us. And so with the modern radio fan. He cannot help but notice the many new and distinctive radio devices set out for his scrutiny and deliberation.

To list and illustrate all, or even a goodly portion of such devices, is rather impossible in such a limited space, but a few that have been tested and approved by the Radio Broadcast Laboratory are depicted here.

Manufacturers, it can easily be seen, are bent on simplifying the operation of the radio receiver, and at the same time there is a very evident trend toward beautifying the appearance of the complete radio installation both inside and outside the receiver cabinet.

The Acme Trickle Charger, shown below, makes possible the recharging of one's storage battery after the set is switched off for the night. It is a compact instrument measuring only about 5 x 3½ x 5¾ inches, and operates from 110 and 115 volts a. c. The charging rate is .5 ampere.

For the home constructor interested in the super-heterodyne, the St. James 280 kc. intermediate-frequency amplifying transformers will offer something brand new and of decided interest. The transformer primary and secondary coils, which are of the honeycomb type, are enclosed in an air evacuated glass tube resembling a radio vacuum tube in a socket.

From the L. S. Brach Company come two fine additions to radio equipment. The Brach lightning arrester will appeal, especially for summer use, to all who desire a serviceable device which will dissipate the electrical charges that might collect in the antenna. A lightning arrester of an approved type is a good investment, since it makes of the antenna system a very efficient protection against lightning. The second device received from this company is a charging resistor control which may be used for regulating, by means of a calibrated resistance, the rate of trickle charge of A storage batteries, and reduces this function to the mere turning of a switch.

Cardwell's new taper plate condenser is a distinctive contribution to the radio market. It is different from most of the s.l.f. condensers in that the straight line curve is obtained by the use of tapered plates which vary the air space between the rotor and stator plates as the former is rotated, without employing the long, slender plates as is common with most s.l.f. condensers.

Two types of meters offer to the laboratory man and home radio enthusiast a means of checking up on the conditions of his batteries, the A, B, or C. The Hoyt meter, shown on the top of the first page, is of novel pattern. With it, five different sets of readings may be taken by merely turning the meter in its support for each individual range. One connection to the meter is common, while the second connection goes to one or other of the remaining binding posts, depending upon which reading is desired. The possible readings are as follows: 0–75 volts; 0–150 volts; 0–7.5 amperes; 0–15 milliamps.; and 0–75 milliamps.

The Cellokay meter has been designed for telling the actual state of the A battery when its terminals are applied across the latter's posts. A direct reading is obtained which tells at a glance whether the battery is "Full," "Half-Full," or "Low."

From the Richard Davis Company we have received a combined loop and Timmons cone arranged in a very attractive style. It is possible to rotate the loop on two axes thereby adjusting it to the actual plane of the wave front of the intercepted radio wave. In short, this device combines both the input and output units of a receiver—the loop and speaker.

The man building his own plate-supply unit will find the Tobe Deutschmann B Block of especial interest. Gathered into one can are all the condensers that are necessary for the filter and by-pass circuits of a plate-supply unit. Appropriate binding posts afford means for connections to two 1-mfd. sections, two 2-mfd. sections, and one 8-mfd. section.

The three gang condenser of .00035-mfd. capacity for tuning three circuits simultaneously, is manufactured by the United Scientific Laboratories, Inc. Novel vernier adjustments on two sets of the stator plates make it possible to compensate for slight differences between the coils in a three-circuit receiver.

The Walbert .00035-mfd. variable condenser indicates a tendency prevalent among manufacturers toward dust proof enclosed condensers. Considering that much can happen in the way of noise production caused by dusty, dirty plates in a variable condenser, this is a step to be commended.

Those fans who have contemplated the purchase of a Bosch cone loud speaker will be interested to know that the Bosch Magneto Company are putting out one of their cones with a wicker work front to harmonize with summer porch furnishings. The Laboratory has not been given the opportunity to test the Bosch cone.

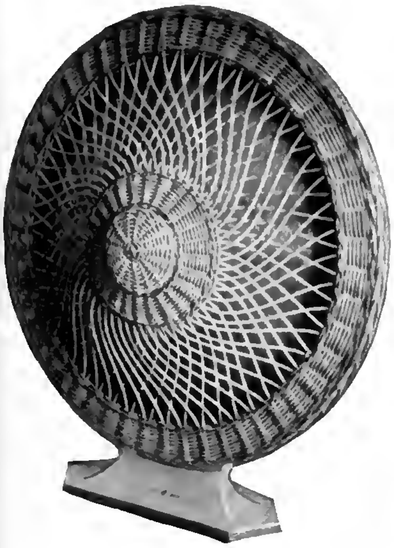
THE ACME TRICKLE CHARGER

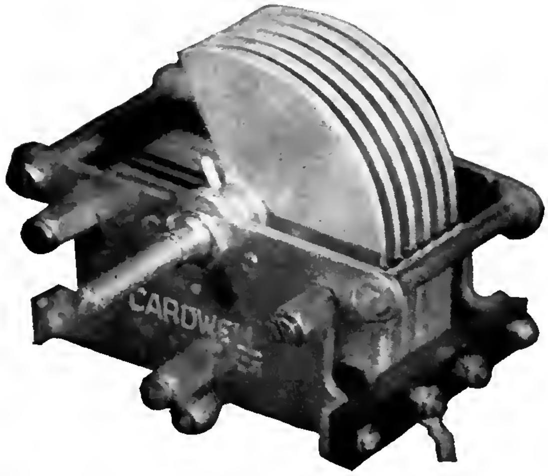
Photographs by Radio Broadcast

BRACH'S LIGHTNING ARRESTER

AN R. F. TRANSFORMER

THE NEW BOSCH CONE

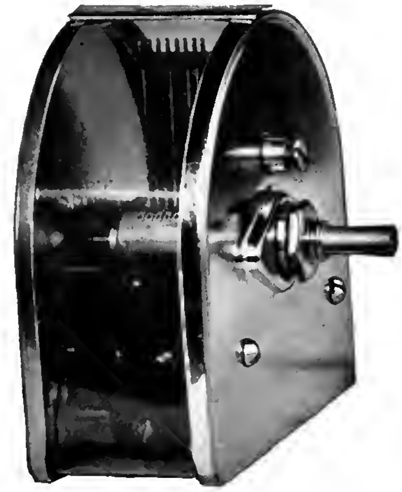




Photographs by Radio-Broadcast

CARDWELL'S TAPER PLATE CONDENSER

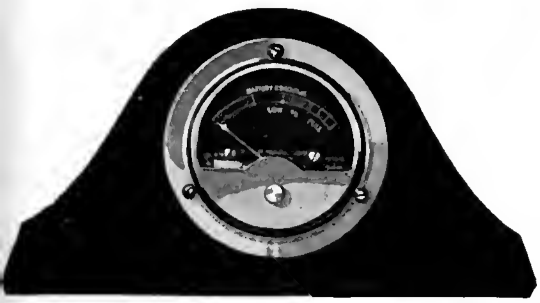
A DUST-PROOF CONDENSER —WALBERT'S



A COMBINED LOOP AND TIMMONS CONE

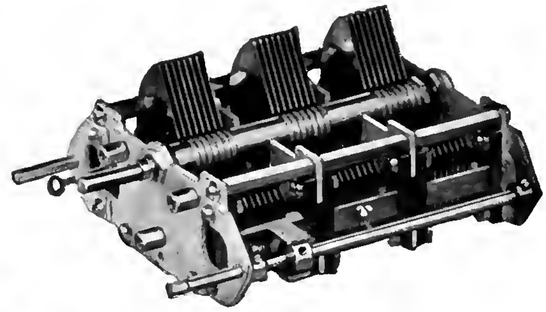
THE TOBE DEUTSCHMANN B BLOCK

HOYT'S "ROTARY" METER



THE CELLOKAY METER

By connecting it across the A battery, the needle will indicate the condition of the battery by pointing to either "Low," "Half," or "Full." To the right, Brach's charging control—suitable for trickle chargers



A TRIPLE GANG CONDENSER

It is a production of the United Scientific Laboratories (U. S. L.). To compensate for slight differences in the coils employed (which are naturally matched as closely as possible), two groups of stator plates have verniers

How Radio Wire Lines are Equalized

Technical Practice in England and America—Details of the Operation of American Broadcasting Stations—The Rôle of the Engineer in Radio—Comment of Interest to Broadcasters and the Public

"AS THE BROADCASTER SEES IT"

By CARL DREHER

Drawings by Stuart Hay

THE elementary theory of loss of high frequencies in audio transmission over wire lines and cables, and simple methods of correction or equalization were discussed in the May RADIO BROADCAST. The treatment of this subject will now be continued with a description of a number of types of equalizers in common use in broadcasting.

First, however, it should be understood that in line correction, as in politics, there is no universal remedy or panacea. Each case requires individual treatment, depending on the nature and length of the circuit, terminal apparatus, and transmission requirements. Open wire lines, consisting of wires strung on crossarms fastened to poles, require the least degree of correction, since the capacity is relatively low. Such lines, of course, are not as reliable in sleet or wind as aërial or subterranean cables, in which a large number of pairs are bunched and encased in some suitable protective covering, such as lead, or insulating fabrics possessing the requisite mechanical strength. On the other hand, a cable, with the two sides of a pair in contact (insulation to insulation, that is) and also close to other conductors has a much higher capacity per unit length than an open wire pair with the two wires separated by several inches or feet of air. As a result, the attenuation, or loss of energy, is much greater for a given distance, and likewise the loss of higher frequencies is not as easily corrected.

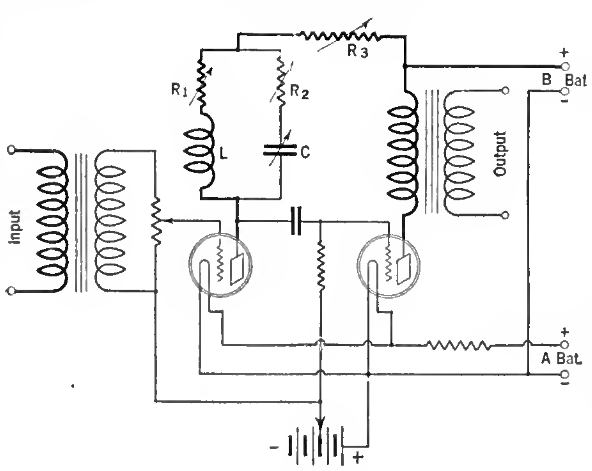


FIG. 1
British practise in line equalizing

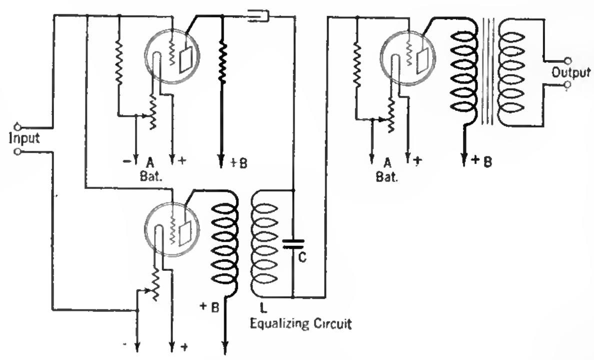


FIG 2
The Weinberger amplifier "flat" to 4000 cycles and "rising" from 4000 to 10,000 cycles

In one instance a 225-mile circuit between two cities, almost all open wire, has a "cable equivalent" of 12 miles. That is, this actual 225-mile run of open wire corresponds to 12 miles of standard cable, with a resistance of 88 ohms and capacity of 0.054 microfarads per loop mile, and the 12 miles of standard cable may be used as its equivalent in all calculations. Another circuit between the two cities contains 23 physical miles of cable, in three sections, the rest being open wire. This circuit has a cable equivalent of 40 miles, and is correspondingly harder to equalize. The type of cable is also a factor. In the second case cited above, the cable sections are what is known as five-pair, 14 gauge paper lead cable, which means that there are five pairs of wires, size No. 14 B. & S. copper, the wires insulated from each other by paper covering, with a lead sheath over all.

The only type of cable adaptable to broadcasting use is "paired" cable, in which the two wires of a circuit are twisted, and sometimes shielded, to avoid inductive interference from other circuits. "Straight-laid" cable, in which the circuits are not isolated in this way, cannot be used for audio transmission. Even a short section will ruin an otherwise quiet line.

Fig. 1 shows a type of equalizer disclosed in an article on "The Design of a Broadcasting Station," by A. G. D. West, Assistant Chief Engineer of the British Broadcasting Company, published in the *Year Book of Wireless Telegraphy and Telephony* (The *Wireless World, London*). This is designed to equalize between 50 and 8000 cycles per second, and represents English practice in this field. The range of the variables is not given.

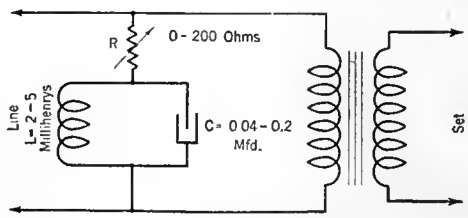


FIG. 3
Shunt equalizer for radio wire lines common in the United States

Fig. 2 shows a correcting amplifier designed by Mr. Julius Weinberger to give a characteristic, flat up to 4000 cycles, and rising from 4000 to 10,000 cycles. This is described in Mr. Weinberger's "Broadcast Transmitting Stations of the Radio Corporation of America," *Proceedings of the Institute of Radio Engineers* Vol. XII, No. 6, Dec., 1924. The rising characteristic is derived from the resonant circuit LC, tuned to 10,000 cycles, with a capacity C equaling 0.00025 mfd.

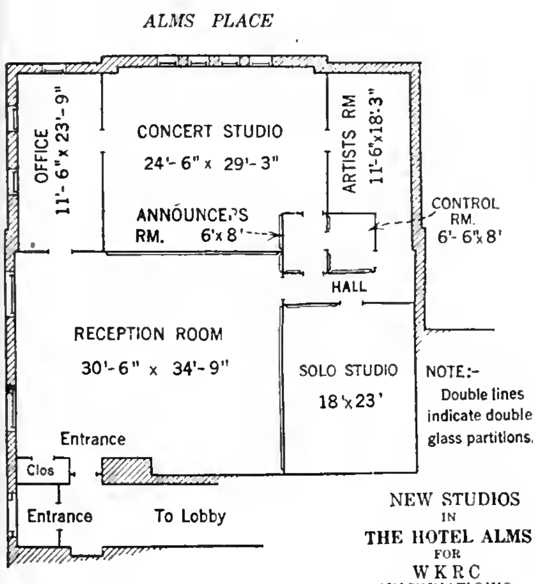
The simple shunt equalizer used generally in this country is shown in Fig. 3. A typical range of constants is given. The theory of operation is simple. The coil-condenser circuit is resonant to some high audio frequency, say 5000 cycles. Across its terminals it presents a very high impedance to currents of this order of frequency, so that it has little effect on their strength and they pass on undiminished to the input equipment. For currents of low frequency, the coil L is practically a short circuit. The combination is therefore an equalizer, dropping out the excess of low notes and retaining the high. The series resistance R regulates the degree of equalization. When the entire resistance is out, leaving the shunt circuit bridged directly across the line, equalization is at a maximum. So is the loss in signal strength, which must be compensated for by amplification.

Among the Broadcasters

WKRC

THE sketch shows the new studio layout of WKRC of Cincinnati, in the north wing of the new Hotel Alms. The 125-foot towers are on the roof of the building. It is said that the arrangement shown was not decided on until two of the officials of the staff had visited twenty-six broadcasting stations in the United States.

The space occupied by the WKRC layout



NEW STUDIOS IN THE HOTEL ALMS FOR WKRC CINCINNATI, OHIO

is about 3600 square feet. This area includes a large orchestration studio, solo studio, control room for the studio director and announcer, a separate operating control office, a private office for the studio director and engineer, a promenade, artists' lounge room, and a large reception hall. Both studios and the announcer's control office are glass-enclosed to permit visitors to watch the broadcasting.

The ceilings of both studios are to be sound-proofed with felt. The walls will be constructed of double thicknesses of sound insulating material, so that each studio will be effectively isolated. The finish will be white, and the acoustic composition used will give the effect of blocks of caen stone. Italian period furniture, suitable draperies and paintings will complete the arrangement.

WENR

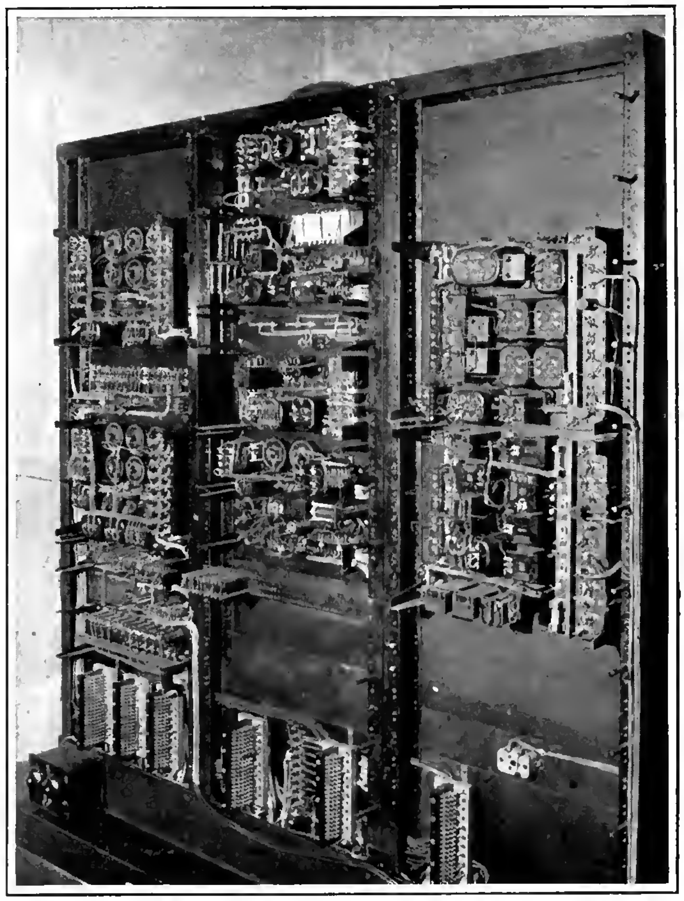
OUR photograph of the new downtown studio of WENR, operated by the All-American Radio Corporation, located in the Kimball Hall Building, Chicago, is not printed to show the two pretty girls and Frank Westphal, the studio director and announcer, but to give technically inclined readers an opportunity to observe the method used to reduce the reverberation time of the studio. Instead of deadening the room by means of drapes, an equivalent acoustic effect has been secured by means of the solid absorbing material used for the walls.

But who put the microphone on the piano? We will wager that none of the operators were around when that photograph was posed.

A NEW STUDIO OF WENR, CHICAGO WHICH HAS A NOVEL WALL TREATMENT

WBAL

YOU are next invited to gaze on the studio control panels (rear view) of WBAL, Baltimore, Maryland. Apparently not all the equipment was in when this photograph was taken. There is enough, however, to enable you to understand why a broadcasting station gets out of order once in a while.



REAR VIEW, STUDIO CONTROL PANELS—WBAL, BALTIMORE

WEAF

ONE of the best known regular features on the air is the Sunday night Capitol Theatre broadcast through WEAF, New York and its chain. The smooth and perfectly controlled job invariably turned

"HE WAS A GENIUS—HE FREQUENTLY SAID SO HIMSELF"

out is no accident. One of the reasons, we are told, is that two of the control engineers assigned to cover the evening program listen to the Sunday afternoon performance in company with the assistant conductor of the theatre, taking notes which later guide them in producing a first-class piece of work in transmission.

It may also be of interest to consider the amount of equipment tied up whenever the big duck, WEAF, and all the little ducklings, to the number of about fifteen, are connected together by wire lines. According to Mr. George F. McClelland, Manager of Broadcasting for WEAF, 9300 miles of wire are used to carry an important program from the Atlantic coast to stations east of the Missouri River, from Minneapolis on the north to St. Louis on the south. The currents travel through underground circuits and over 124,000 telephone poles. The telephone lines, as originally designed and installed, were intended only for transmission of the essential frequencies of speech. The lines used for broadcast transmission must be equalized over a far greater range, in order that natural speech and music may be delivered to the various stations on the chain. About one hundred men cover the transmission, not only in the broadcasting stations themselves, but at twenty-four repeater stations along the lines, where the audio currents are boosted in order to maintain proper quality and margin over noise.

WHT

THROUGH Reeve O. Strock, the chief engineer, WHT reports the installation of a "mixing panel", a device such as was described in the April, 1926, RADIO BROADCAST, to secure greater flexibility in balancing musical ensembles. The report does not give much in the way of circuit details, but it is stated that five studio microphones and all incoming lines may be put on the air simultaneously in any volume proportion desired.

The Rôle of the Engineer in Radio

IF I were entirely ignorant of radio conditions, in a technical sense, wanted to buy a good receiving set, and had no means of getting expert counsel, I should adopt the following curious procedure. Instead of listening to salesmen, who, in my unprepared state, would probably merely befuddle me with their talk, or reading advertisements, which nearly always start with the claim that the set advertised is the eighth wonder of the world, I should try to find out what percentage of their gross income various manufacturers devote to research. When I had discovered the one with the highest ratio in that regard, I should look over a list of his sets, buy the most expensive I could afford, and let it go at that. I might not end up with the best receiver I could buy for the money, but I rather think I would. Neglecting all the other factors involved, the single consideration I have suggested would probably set one on the right path.

The fact is that in radio, as in every other field, one is not apt to get something for nothing. And progress must be bought like everything else. One manufacturer turns out a better product than another, as a rule, because he spends more in finding out how to make his machines superior. It is really astonishing how many radio manufacturers have gone into production on a formidable scale, advertised extensively, sent out an army of salesmen, and invested a gold-mine in the whole structure, when they really had nothing to sell. The product itself was the last thing they thought about. A radio receiver, to them, was a radio receiver. An engineer was anybody who said he was an engineer and could get a few other people, who also said they were engineers, to say that he was an engineer. If he was given the title of Chief Engineer, then all doubt was dispelled. The man was a genius—he frequently said so himself—and that his words dripped with wisdom was proved by the fact that he always spoke in such intricate and technical terms that the promotors of the enterprise could not make head or tail of what he said. All that remained was to put his masterpiece into a fancy box and wait for the money to roll in. . . . Sometimes the creditors have received as much as twenty cents on the dollar.

In this day of high pressure salesmen, well nourished advertising agencies, fifty-thousand-a-year executives, scientific management, expert industrial prophets, and all modern improvements, it is well to remember that our little radio world rests on the shoulders of only one Atlas, the engineer. Or, if you prefer Biblical to mythological figures, do you remember the injunction to build your house upon a rock? If so, you have a better memory than many of the radio set manufacturers whose stock issues dropped from the twenty dollar to the fifty cent class during 1925. Look into the cause of these sad declines, and you will find them many and various, but there is one factor which turns up in seventy-five per cent. of all wrecks, and that is poor or mediocre engineering. The thing started wrong, and it would be a miracle if it had ended right. And miracles occur in hagiology, seldom in radio.

What, then, is this engineer, whose horn I blow so loudly? It has been said that an engineer is a man who can do with one horsepower what any fool can do with two; and that is not a bad definition. Going back a step, we find that this efficiency arises from superior quantitative knowledge. The engineer knows definitely where he "is at" and where he wants to go. But so does a shop-foreman. Going back another step, it appears that the engineer's proficiency rests on the organized body of technical knowledge handed down to him through the various sciences from which his art is derived. He knows his underlying physical theory, is able to express it mathematically, that is, succinctly, exactly, and generally, to confirm it by measurement, and finally to apply it practically to his machine. The engineer is to the cut-and-try set constructor what Oscar of the Waldorf is to a chef in a hash-house.

The necessity for design and production engineers is obvious, since they must be depended on to get out the product. The department which is more likely to be neglected is that of research and development. Instead of parting with the necessary cash for a development division, some short sighted executives think they can get away with it by imitating their competitors. This has two disadvantages. One is that the competitors may not be worth imitating. The other is that the copying firm is always a year or so behind the copied. The proper procedure is to originate when one can and to adapt good ideas derived from competing sets, when expedient, and as far as business ethics will allow. All manufacturers keep an eye on competing sets, and know their good and bad points quite as well as they know the strength and weakness of their own equipment. That is, all manufacturers who are not asleep, and in industry, as when one is freezing, sleep is death. If you walk into the laboratory of a manufacturer of loud speakers, you will find every model of loud speaker on the market, some intact and some taken apart. Furthermore, there will be characteristic curves of all these instruments, showing how some of them lose the low frequencies, some the high, and some both, and depicting the various humps and troughs which make them what they are. But the enterprising manufacturer and his engineers do not spend much time chuckling over the faults of competing makes; they try, rather, to evolve something superior to anything hitherto known, and to surpass themselves as well as their rivals. And this holds for all the numerous parts and complete sets on the market; in every case the firms interested fall into two main classes: those who strive for improvement and those who are satisfied to copy the leaders. The former class is also found to be soundly financed, while the camp-followers generally skate on thin ice. Good research is one of the elements of sound financing; it is insurance against dropping behind in the race for technical supremacy, which, in the last analysis, determines profits.

Sound engineering is as important in development and operation of broadcasting stations as in the manufacture of receiving equipment. The two fields are analogous, development having its place in each, followed by production in one case and operation in the other. There has never been a first class broadcasting station without a first class development division behind it. If you see a station that remains unchanged from year to year, all you may safely conclude is that it may have been a good station once. It is not only a matter of apparatus, but also of sound methods in operation. Tests and procedures must be carefully planned or a smooth performance on the air need not even be hoped for.

If the engineering is unsound, no amount of brilliant program work will make up for that weakness. An instance: a very important dinner was to be broadcast. In addition to the speakers at the banquet, it was necessary to furnish public address service in the banquet hall on the entire output of the broadcasting station. That is, programs from other cities were to be broadcast and simultaneously made available through the public address system to the diners. The best method of handling this was to feed the public address system continuously from the control room amplifiers of the station.

As a new amplifier system was being installed at the hotel, it was impossible to test the lay-out until a few hours before the dinner was to start. Then, to the consternation of everyone, the combination of public address and broadcasting station audio amplifiers howled lamentably as soon as the connections were made. The diagnosis was simple—coupling between the pick-up microphones and the loud speakers in the banquet hall. The tables were all set up, the speakers' platform had been placed, nothing remained but to bring on the food. But without the public address and radio service the banquet would have been, as the boys in the shipping room say, a flop. What was to be done? It was a problem that had to be solved in a hurry. One of the engineers looked around in the annoying, ruminative way these bipeds have in such situations. He observed a small balcony, which he inspected thoughtfully. He went under it and clapped his hands. He went back into the middle of the room and clapped them some more. He directed an assistant to stand under the balcony and slap his palms together enthusiastically, while the first engineer stood at the far end of the hall and listened. He then had a microphone placed under the balcony. The assistant spoke to it. The system reproduced without howling. "If the speakers' table is placed in the lee of that balcony," remarked the engineer, "you will get public address service. Otherwise not." And immediately all the king's horses and all the king's men were set to moving the speakers' table under the balcony, and the banquet was run off successfully. The incident was not an unusual one. In the last analysis, if the engineer's part of the show is sick, the whole show is sick. If he crashes, all is lost. He is the foundation and the framework. Let the elegant gentlemen in the superstructure remember that.

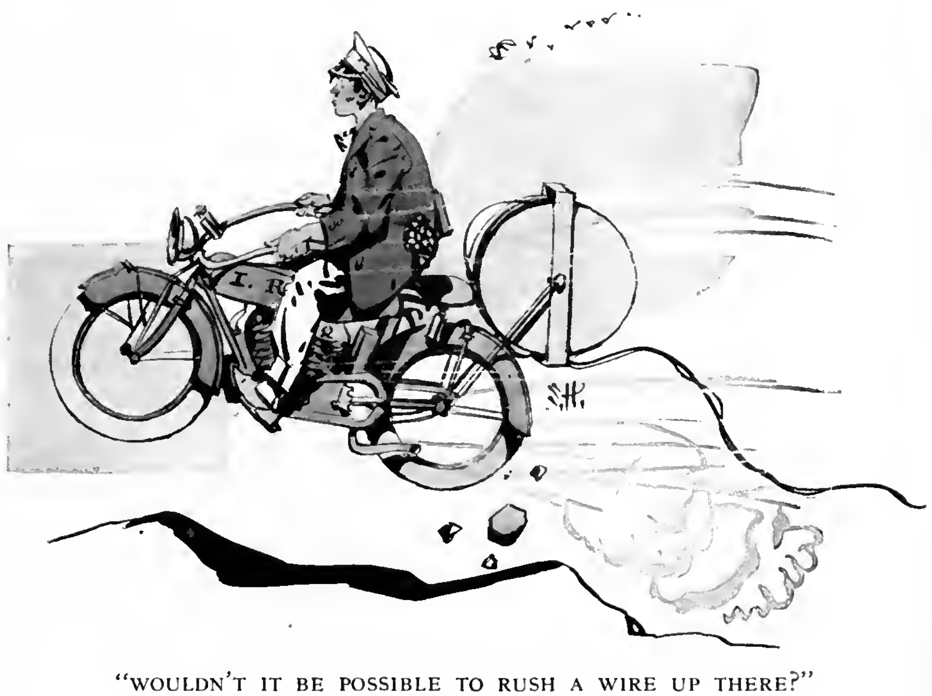
"Please Send Up a Wire"

SOME time ago, in this dizzy department of an otherwise respectable publication, I wrote a skit entitled, "The Laying of the Lines." This opus was my burlesque conception of a young woman radio critic's idea of remote control, derived from a paragraph written by the fair one (since departed from the radio ranks), in which she gave it as her opinion that the lines between New York and Schenectady must have been "carelessly laid" on one occasion when they became noisy during a concert. Pouncing on this phrase, I wrote a piece in which I pictured myself as "laying the lines" by rushing up the east bank of the Hudson with a roll of twisted pair under my arm. One must write about something.

Extravagant? Absurd? Even so. And yet it was brought home to me, the other day, that whatever nonsense one writes, it will be only a little more foolish than the sober thoughts in some people's heads. Attend, then, to a true story.

A movie actor, nationally famous and fabulously rich, had finished a new picture. For the sake of the publicity, the producer arranged to broadcast some scenes from the photoplay, with a musical accompaniment, and to add to the interest, the star was to speak from the studio to the radio audience.

The arrangements having been made in the usual manner, and the event scheduled for a certain evening, a telephone call was received at the broadcasting station on the afternoon of that day from a third assistant secretary of the cinema celebrity. The substance of it was that Mr. X desired to attend a prize-fight in Two Hundred and Twelfth Street (about nine miles from the studio) that evening, and would it not be possible to rush a wire



"WOULDN'T IT BE POSSIBLE TO RUSH A WIRE UP THERE?"

up there, so that Mr. X could broadcast without missing his diversion?

Yes, truth will beat fiction any day. The name of the miracle-seeking star will be given on application to any United States Senator.

Memoirs of a Radio Engineer. XII

"MY MAGAZINES SERVED SOMEWHAT LIKE A LOVER'S PICTURE OF HIS SWEETHEART"

MY ACCOUNT so far has been of urban amateur radio. I did, indeed, take radio with me on my vacations, but only in the form of magazines on the subject, manufacturers' catalogues, and the like. As I was going to school, I enjoyed a vacation period of some two months each summer, which was spent in the Catskills, as a rule. The radio reading matter which I took away with me served somewhat like a lover's picture of his sweetheart, and had the same limitations. After a month's absence from my receiving set, I usually felt a great longing to hear actual signals again, and there were several years when I returned to the city a week or so sooner than was necessary, because my craving for dots and dashes could no longer be restrained. A curious mania, and one which I scarcely comprehend to-day, although I remember it clearly enough. Presumably what killed it was an overdose of dots and dashes when I went into radio professionally.

In 1913, however, my family occupied a cottage in Bushnellsville, Greene County, New York, and my receiving equipment went up there with me. It consisted of a loose-coupler covering a range of from 300 to 3000 meters, approximately, galena detector, and 2000-ohm telephones, with the usual accessories. The water supply in the house came from a spring about 2000 feet distant, through galvanized iron pipe, partly on the surface and partly buried; this gave me a good ground. I strung a single-wire antenna to a tree about 250 feet from the house, and higher up the hill. I climbed the tree and my sister helped me on the ground. The height of the free end of the wire must have been around 40 feet, and it was practically parallel to the side of the hill on which the cottage stood, so that it had a slope of thirty degrees or so, reckoning from the horizontal, and fell into the class of sloping, or, as they were then sometimes called, "compromise" antennas. The lower end of the wire was supported by a tree about thirty feet high, and thence the lead-in dropped vertically to my window.

Bushnellsville is practically in the center of the Catskill range, about 120 miles northwest of New York City, with mountains for thirty miles and more in every direction. The elevation is 1600 feet above sea level, and the tops of the mountains rise 1400 feet higher. Under such unfavorable receiving conditions I had little hope of picking up daylight signals, and I never did. I listened often, but heard only static crashes, and plenty of them, because scarcely a day passed in this valley without a lightning storm of greater or lesser severity. But what I expected to get was the nightly press report of WSL, the Atlantic Communication Company's large station at Sayville, Long Island. This transmitter was a Telefunken spark set rated at 35 kilowatts. I don't know what the actual antenna power or "Turm Kraft," as the German engineers called it, amounted to—possibly something in the neighborhood of 10 kilowatts. Anyway, it was the powerful set of its time, and did a great business communicating with vessels crossing the Atlantic, which it sometimes worked as far east as Gibraltar. The wavelength was somewhere up in the two thousands, about 2800, if I recollect, and each night it sent several thousand words of press, starting around 8 P. M., at about 12 words a minute, including news items, baseball scores, and other items of interest. I was able to get a very readable signal from WSL, and copied him every night. In this way I had the baseball scores every night at about ten o'clock, when nobody else in Bushnellsville knew them until noon the following day. Then the mail, including newspapers, arrived by stage coach, the village being four miles from the nearest railroad station. Most of the natives knew nothing about radio, and believed that I secured the ball scores by some sort of necromancy.

Sayville was the only station I could get reliably. Time signals from NAA, Arlington, were weak, although generally audible at the 10 P. M. transmission. On 600 meters I heard a few ships, and WSC, the Marconi station at Siasconsett, Massachusetts. None of the New York city stations ever let out a peep as far as Bushnellsville was concerned. Mountain reception on a crystal was a different proposition from my city experiences, relatively close to WNT, NAH, and WCG. But, even as conditions were more difficult, the thrill of being in touch with the outside world was greater. There was a peculiar incongruity between the green clad hills and my antenna, and the mastery of space which radio communication gives to man seemed more remarkable in the hills than in the city, where mechanical appliances and triumphs are the regular thing.

In walking and driving about the Catskills in those years (1912-1914) I never saw another antenna. I have sometimes wondered whether I was the first to introduce radio into the haunts of Rip Van Winkle, in the summer of 1913. If there are any other claimants to the honor, let them speak now, or forever hold their peace.

¶ A regular portion of Mr. Dreher's department, "As the Broadcaster Sees It" is devoted to technical procedure in broadcasting stations. That section of his department is of especial interest and help to the many engineers and others engaged in the daily solving of problems of broadcasting. Mr. Dreher invites contributions from other broadcasting engineers, telling of kinks of operation, or any kind of short report on their daily technical experiences which will be helpful to those similarly engaged. All contributions accepted will be paid for at our regular space rates. We believe, also, that the technical side of the operation of a broadcasting station is of deep interest to the great body of radio experimenters as well as to those who make their living supplying broadcast service to the listener. The material appearing in this department is so written that it is sufficiently technical to be of help to the engineer, but yet not too involved for the average experimenter to comprehend.

MILES FROM ↓ TO →	BOSTON	CHICAGO	CINCINNATI	CLEVELAND	DETROIT	NEW YORK	PHILADEL-PHIA	PITTS-BURGH	ST. LOUIS
Atlanta, Ga.	930	590	375	550	595	745	660	520	470
Baltimore, Md.	350	600	420	315	405	170	85	200	730
Birmingham, Ala.	1050	580	415	615	640	855	775	610	400
Boston, Mass.	—	840	730	540	600	190	270	475	1100
Buffalo, N. Y.	400	450	395	175	215	295	280	180	655
Calgary, Alta.	2060	1370	1620	1645	1555	2000	1200	1755	1950
Chicago, Ill.	840	—	230	300	225	700	650	400	250
Cincinnati, O.	730	230	—	215	225	560	500	250	300
Cleveland, O.	540	300	215	—	75	400	350	110	480
Dallas, Tex.	1515	800	795	1000	990	1350	1280	1060	540
Davenport, Ia.	990	160	360	455	390	860	800	560	200
Denver, Colo.	1750	900	1080	1200	1140	1600	1550	1310	775
Des Moines, Ia.	1135	300	500	605	540	1010	965	710	265
Detroit, Mich.	600	225	225	75	—	475	435	200	440
Elgin, Ill.	870	35	280	335	260	740	690	440	255
Galveston, Tex.	1585	945	880	1100	1090	1400	1315	1125	690
Hastings, Neb.	1400	560	740	865	795	1265	1215	965	445
Havana, Cuba	1500	1315	1100	1250	1325	1300	1270	1215	1165
Indianapolis, Ind.	790	160	100	255	230	630	575	325	230
Iowa City, Ia.	1045	200	405	505	435	900	860	600	210
Joliet, Ill.	870	35	250	330	260	730	680	430	225
Kansas City, Mo.	1225	400	545	690	640	1080	1025	775	230
Lansing, Mich.	680	170	240	170	85	550	520	280	400
Los Angeles, Cal.	2560	1730	1875	2020	1950	2420	2360	2110	1565
Louisville, Ky.	815	270	90	300	310	645	570	345	245
Madison, Wisc.	925	120	370	405	325	800	760	520	300
Memphis, Tenn.	1120	480	410	620	615	950	870	655	240
Mexico City, Mex.	2300	1675	1600	1800	2120	2115	2035	1860	1420
Miami, Fla.	1280	1180	950	1085	1150	1100	1025	1010	1050
Milwaukee, Wisc.	840	80	320	335	255	725	690	450	325
Minneapolis, Minn.	1110	360	590	620	545	1005	980	750	465
Montreal, P. Q.	260	740	700	490	515	335	400	470	970
New Orleans, La.	1340	820	700	910	925	1150	1080	910	590
New York, N. Y.	190	700	560	400	475	—	90	310	870
Oakland, Cal.	2650	1820	2000	2115	2030	2500	2490	2240	1705
Philadelphia, Pa.	270	650	500	350	435	90	—	250	800
Pittsburgh, Pa.	475	400	250	110	200	310	250	—	550
Providence, R. I.	40	825	700	525	585	150	235	450	1000
St. Louis, Mo.	1100	250	300	480	440	870	800	550	—
San Francisco, Cal.	2650	1820	2020	2140	2065	2540	2500	2240	1715
Schenectady, N. Y.	145	700	600	400	460	150	210	350	900
Seattle, Wash.	2500	1710	1950	2000	1920	2400	2385	2115	1695
Springfield, Mass.	80	760	645	460	525	120	200	395	960
Tampa, Fla.	1160	1060	775	925	985	1000	930	870	855
Toronto, Ont.	440	425	400	190	200	350	340	225	640
Valparaiso, Ind.	815	45	200	270	210	670	625	370	255
Washington, D. C.	390	590	400	300	390	200	125	190	705
Winnipeg, Man.	1350	710	970	940	850	1295	1275	1050	845
Worcester, Mass.	40	800	700	500	570	155	235	435	985
Zion, Ill.	850	45	285	320	240	720	675	420	290

RADIO BROADCAST'S

Booklet of

American and Canadian Broadcasters

May 15, 1926

Arranged by
LAWRENCE W. CORBETT

Log Sheet

CALL SIGNAL	WAVE-LENGTH	FREQUENCY	DIAL 1	DIAL 2	DIAL 3	REMARKS

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
KFMX	Northfield, Minn.	890	336.9	500
KFNF	Shenandoah, Ia.	1140	263	1000
KFOA	Seattle, Wash.	660	454.3	1000
KFOB	Burlingame, Cal.	1330	226	50
KFON	Long Beach, Cal.	1290	233	500
KFOO	Salt Lake City, Utah	1270	236	250
KFOR	David City, Neb.	1330	226	100
KFOT	Wichita, Kans.	1300	231	50
KFOX	Omaha, Neb.	1210	248	100
KFOY	St. Paul, Minn.	1190	252	50
KFPL	Dublin, Tex.	1190	252	15
KFPM	Greenville, Tex.	1240	242	10
KFPR	Los Angeles, Cal.	1300	230.6	500
KFPW	Carterville, Mo.	1160	258	20
KFPY	Spokane, Wash.	1130	266	100
KFQA	St. Louis, Mo.	1150	261	100
KFQB	Fort Worth, Texas	1140 590	263 508.2	1000 }
KFQD	Anchorage, Alaska	1320	227.1	100
KFQP	Iowa City, Ia.	1340	224	10
KFQU	Holy City, Cal.	1380	217.3	100
KFQW	North Bend, Wash.	1390	215.7	50
KFQZ	Hollywood, Cal.	1330	225.4	50
KFRB	Beeville, Tex.	1210	248	250
KFRC	San Francisco, Cal.	1120	268	50
KFRU	Columbia, Mo.	600	499.7	500
KFRW	Olympia, Wash.	1370	218.8	50
KFSG	Los Angeles, Cal.	1090	275	500
KFUL	Galveston, Tex.	1160	258	50
KFUM	Colorado Springs, Colo.	1250	239.9	100
KFUO	St. Louis, Mo.	550	545.1	500
KFUP	Denver, Colo.	1280	234	50
KFUR	Ogden, Utah	1340	224	50
KFUS	Oakland, Cal.	1170	256	50
KFUT	Salt Lake City, Utah	1150	261	100
KFUU	Oakland, Cal.	1360	220	50
KFVD	San Pedro, Cal.	1460	205.4	50
KFVE	St. Louis, Mo.	1250	240	500
KFVG	Independence, Kans.	1270	236	15
KFVI	Houston, Tex.	1250	240	10
KFVN	Welcome, Minn.	1320	227	50
KFVS	Cape Girardeau, Mo.	1340	224	50
KFVW	San Diego, Cal.	1220	246	500
KFVY	Albuquerque, N. Mex.	1200	250	10
KFWA	Ogden, Utah	1150	261	500
KFWB	Hollywood, Cal.	1190	252	500
KFWC	Upland, Cal.	1420	211.1	50
KFWF	St. Louis, Mo.	1400	214.2	250
KFWH	Chico, Cal.	1180	254	100
KFWI	South San Francisco, Cal.	1330	226	500
KFWM	Oakland, Cal.	1450	206.8	500
KFWO	Avalon, Cal.	1420	211.1	250
KFWU	Pineville, La.	1260	238	100

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
KDKA	East Pittsburgh, Pa.	970	309.1	Varies
KDLR	Devils Lake, N. Dak.	1300	231	5
KDYL	Salt Lake City, Utah	1220	246	50
KFAB	Lincoln, Neb.	880	340.7	1000
KFAD	Phoenix, Ariz.	1100	273	100
KFAF	San Jose, Cal.	1380	217.3	50
KFAU	Boise, Idaho.	1070	280.2	750
KFBB	Havre, Mont.	1090	275	50
KFBC	San Diego, Cal.	1390	215.7	50
KFBK	Sacramento, Cal.	1210	248	100
KFBL	Everett, Wash.	1340	224	100
KFBS	Trinidad, Colo.	1260	238	15
KFBU	Laramie, Wyo.	1110	270	500
KFCB	Phoenix, Ariz.	1260	238	100
KFDD	Boise, Idaho.	1080	278	50
KFDM	Beaumont, Tex.	950	315.6	500
KFDX	Shreveport, La	1200	250	100
KFDY	Brookings, S. Dak.	1100	273	100
KFDZ	Minneapolis, Minn.	1300	231	10
KFEC	Portland, Ore.	1210	248	50
KFEL	Denver, Colo.	1180	254	50
KFEQ	Oak, Neb.	1120	268	500
KFEY	Kellogg, Idaho	1290	233	10
KFFP	Moberly, Mo.	1240	242	50
KFGQ	Boone, Ia.	1330	226	10
KFH	Wichita, Kans.	1120	268	500
KFHA	Gunnison, Colo.	1190	252	50
KFHL	Oskaloosa, Ia.	1250	240	10
KFI	Los Angeles, Cal.	640	468.5	4000
KFIF	Portland, Ore.	1210	248	100
KFIO	Spokane, Wash.	1130	265.3	100
KFIQ	Yakima, Wash.	1170	256	100
KFIU	Juneau, Alaska	1330	226	10
KFIZ	Fond du Lac, Wisc.	1100	273	100
KFJB	Marshalltown, Ia.	1210	248	10
KFJC	Junction City, Kans.	1370	218.8	10
KFJF	Oklahoma, Okla.	1150	261	500
KFJI	Astoria, Ore.	1220	246	10
KFJM	Grand Forks, N. Dak.	1080	278	100
KFJR	Portland, Ore.	1140	263	50
KFJY	Fort Dodge, Ia.	1220	246	50
KFJZ	Fort Worth, Tex.	1180	254	50
KFKA	Greeley, Colo.	1100	273	50
KFKU	Lawrence, Kans.	1090	275	500
KFKX	Hastings, Nebr.	1040	288.3	5000
KFKZ	Kirksville, Mo.	1330	226	10
KFLR	Albuquerque, N. Mex.	1180	254	100
KFLU	San Benito, Tex.	1270	236	10
KFLV	Rockford, Ill.	1310	229	100
KFLX	Galveston, Tex.	1250	240	10
KFLZ	Anita, Ia.	1100	273	100
KFMR	Sioux City, Ia.	1150	261	100
KFMW	Houghton, Mich.	1140	263	50

Log Sheet

CALL SIGNAL	WAVE-LENGTH	FREQUENCY	DIAL 1	DIAL 2	DIAL 3	REMARKS

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
KFWV	Portland, Ore.	1410	212.6	50
KFXB	Big Bear Lake, Cal.	1480	202.6	500
KFXD	Logan, Utah	1460	205.4	10
KFXF	Colorado Springs, Colo.	1200	250	500
KFXH	El Paso, Tex.	1240	242	50
KFXJ	Denver, Colo. (portable)	1390	215.7	10
KFXR	Oklahoma, Okla.	1400	214.2	15
KFXY	Flagstaff, Ariz.	1460	205.4	50
KFYF	Oxnard, Cal	1460	205.4	10
KFYJ	Houston, Tex. (portable)	1260	238	10
KFYO	Texarkana, Tex.	1440	209.7	10
KFYR	Bismarck, N. Dak.	1210	248	10
KGO	Oakland, Cal.	830	361.2	4000
KGTT	San Francisco, Cal.	1450	206.8	50
KGU	Honolulu, Hawaii	1110	270	500
KGW	Portland, Ore.	610	491.5	500
KGY	Lacey, Wash.	1220	246	50
KHJ	Los Angeles, Cal.	740	405.2	500
KHQ	Spokane, Wash.	760	394.5	1000
KJBS	San Francisco, Cal.	1360	220	5
KJR	Seattle, Wash.	780	384.4	1000
KLDS	Independence, Mo.	680	440.9	1000
KLS	Oakland, Cal.	1200	250	250
KLX	Oakland, Cal.	590	508.2	500
KLZ	Denver, Colo.	1130	266	250
KMA	Shenandoah, Ia.	1190	252	500
KMJ	Fresno, Cal.	1280	234	50
KMMJ	Clay Center, Neb.	1310	228.9	1000
KMO	Tacoma, Wash.	1200	250	100
KMOX	St. Louis, Mo.	1070	280.2	1500
KMTR	Los Angeles, Cal.	1260	238	500
KNRC	Los Angeles, Cal.	1440	208.2	250
KNX	Los Angeles, Cal.	890	336.9	1000
KOA	Denver, Colo.	930	322.4	5000
KOAC	Corvallis, Ore.	1070	280.2	500
KOB	State College, N. Mex.	860	348.6	1000
KOCH	Omaha, Neb.	1160	258	250
KOCW	Chickasha, Okla.	1190	252	200
KOIL	Council Bluffs, Ia.	1080	278	500
KOIN	Portland, Ore.	1410	212.6	500
KOWW	Walla Walla, Wash.	1170	256	500
KPO	San Francisco, Cal.	700	428.3	1000
KPPC	Pasadena, Cal.	1310	229	50
KPRC	Houston, Tex.	1010	296.9	500
KPSN	Pasadena, Cal.	950	315.6	1000
KQV	Pittsburgh, Pa.	1090	275	500
KQW	San Jose, Cal.	1300	231	500
KRE	Berkeley, Cal.	1170	256	100
KSAC	Manhattan, Kans.	880	340.7	500
KSD	St. Louis, Mo.	550	545.1	500
KSL	Salt Lake City, Utah	1000	299.8	1000
KSMR	Santa Maria, Cal.	1430	209.7	100
KSO	Clarinda, Ia	1240	242	500

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
CKAC	Montreal, P. Q.	730	410.7	1200
CKCD	Vancouver, B. C.	730	410.7	1000
CKCK	Regina, Sask.	630	475.9	500
CKCL	Toronto, Ont.	840	356.9	500
CKCO	Ottawa, Ont.	690	434.5	100
CKCW	Durham Co., Ont. (Not Active)	910	329.5	5000
CKFC	Vancouver, B. C.	730	410.7	50
CKNC	Toronto, Ont.	840	356.9	500
CKOC	Hamilton, Ont.	880	340.7	50
CKY	Winnipeg, Man.	780	384.4	500
CNRA	Moncton, N. B.	1030	291.1	500
CNRC	Calgary, Alta.	Uses **CFAC** or **CFCN**		
CNRE	Edmonton, Alta.	Uses station **CJCA**		
CNRM	Montreal, P. Q.	Uses **CHYC, CKAC** or **CFCF**		
CNRO	Ottawa, Ont.	690	434.5	500
CNRR	Regina, Sask.	Uses station **CKCK**		
CNRS	Saskatoon, Sask.	Uses station **CFQC**		
CNRT	Toronto, Ont.	Uses station **CFCA**		
CNRV	Vancouver, B. C.	1030	291.1	500
CNRW	Winnipeg, Man.	Uses station **CKY**		

BY FOLLOWING these instructions, a sixteen-page booklet giving all the call signals, frequencies, wavelengths and power of American and Canadian broadcasting stations, together with a distance computation table and log, will result. Referring to page 153, it will be seen that the page has been divided up into four sections, each section representing a page of the completed booklet. This page is made up of pages one, three, fourteen, and sixteen of the booklet.

The pages should be cut from the magazine with a sharp razor blade as near to the binding as possible. Next, these two pages are carefully cut, each into two, the center horizontal line being taken as a guide. We then have four rectangular sheets, two consisting of original pages 153 and 154, and two of pages 155 and 156. The next procedure is to cut around each of these sheets on the border line. Thus the original page numbers, date, and magazine title will be removed. It is advisable to leave a slight border in this operation to allow for trimming up the finished booklet.

Each sheet is then folded down its center vertical line and the folios inserted within each other according to the page numbers printed.

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WTAQ	Eau Claire, Wisc.	1180	254	100
WTAR	Norfolk, Va.	1150	261	100
WTAW	College Station, Tex.	1110	270	500
WTAX	Streator, Ill.	1300	231	50
WTAZ	Lambertville, N. J.	1150	261	15
WTIC	Hartford, Conn.	630	475.9	500
WWAD	Philadelphia, Pa.	1200	250	250
WWAE	Plainfield, Ill.	1240	242	500
WWAO	Houghton, Mich.	1140	263	250
WWI	Dearborn, Mich.	1130	266	500
WWJ	Detroit, Mich.	850	352.7	1000
WWL	New Orleans, La.	1090	275	100

Canadian Broadcasting Stations

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
CFAC	Calgary, Alta.	690	434.5	500
CFCA	Toronto, Ont.	840	356.9	500
CFCF	Montreal, P. Q.	730	410.7	1650
CFCH	Iroquois Falls, Ont.	600	499.7	250
CFCK	Edmonton, Alta.	580	516.9	100
CFCN	Calgary, Alta.	690	434.5	1800
CFCQ	Vancouver, B. C.	730	410.7	5
CFCU	Hamilton, Ont.	880	340.7	500
CFCT	Victoria, B. C.	910	329.5	500
CFCY	Charlottetown, P. E. I.	960	312.3	50
CFDC	Vancouver, B. C.	730	410.7	10
CFKC	Thorold, Ont. (Not Active)	1210	247.8	75
CFMC	Kingston, Ont.	1120	267.7	20
CFQC	North Saskatoon, Sask.	910	329.5	500
CFRC	Kingston, Ont.	1120	267.7	500
CFXC	New Westminster, B. C.	1030	291.1	20
CFYC	Burnaby, B. C.	730	410.7	500
CHCS	Hamilton, Ont.	880	340.7	10
CHIC	Toronto, Ont.	Uses Station CHNC		
CHNC	Toronto, Ont.	840	356.9	500
CHSC	Unity, Sask.	840	356.9	250
CHUC	Saskatoon, Sask.	910	329.5	50
CHXC	Ottawa, Ont.	690	434.5	250
CHYC	Montreal, P. Q.	730	410.7	850
CJBC	Toronto, Ont.	Uses Toronto District Stations		
CJCA	Edmonton, Alta.	580	516.9	500
CJCD	Toronto, Ont.	840	356.9	50
CJGC	London, Ont.	910	329.5	50
CJKC	Burnaby, B. C.	Uses Station CFYC		
CJSC	Toronto, Ont.	Uses Station CKCL		
CJWC	Saskatoon, Sask.	910	329.5	250
CJYC	Scarboro Station, Ont. (not active)	1030	291.1	500

Twelve

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
KTAB	Oakland, Cal.	1250	240	1000
KTBI	Los Angeles, Cal.	1020	293.9	750
KTBR	Portland, Ore.	1140	263	50
KTCL	Seattle, Wash.	980	305.9	1000
KTHS	Hot Springs, Ark.	800	374.8	500
KTNT	Muscatine, Ia.	1170	256	500
KTW	Seattle, Wash.	660	454.3	1000
KUOA	Fayetteville, Ar.	1000	299.8	750
KUOM	Missoula, Mont.	1230	244	250
KUSD	Vermilion, S. Dak.	1080	278	100
KUT	Austin, Tex.	1300	231	500
KVOO	Bristow, Okla.	800	374.8	500
KWCR	Cedar Rapids, Ia.	1080	278	500
KWG	Stockton, Cal.	1210	248	50
KWKC	Kansas City, Mo.	1270	236	100
KWKH	Kennon Wood, La.	1150	261	500
KWSC	Pullman, Wash.	860	348.6	500
KWUC	Le Mars, Ia.	1190	252	50
KWWG	Brownsville, Tex.	1080	278	500
KYW	Chicago, Ill.	560	535.4	3500
KZIB	Manila, Philippines	1200	249.9	20
KZKZ	Manila, Philippines	1110	270	100
KZM	Oakland, Cal.	1250	240	100
KZRQ	Manila, Philippines	1350	222	500
KZUY	Baguio, Philippines.	833	360	500
NAA	Arlington, Va.	690	434.5	1000
WAAD	Cincinnati, Ohio	1160	258	25
WAAF	Chicago, Ill.	1080	278	200
WAAM	Newark, N. J.	1140	263	500
WAAW	Omaha, Neb.	1080	278	500
WABB	Harrisburg, Pa.	1470	204	10
WABC	Asheville, N. C.	1180	254	20
WABI	Bangor, Me.	1250	240	100
WABO	Rochester, N. Y.	1080	278	100
WABQ	Haverford, Pa.	1150	261	100
WABR	Toledo, Ohio	1140	263	50
WABW	Wooster, Ohio	1450	206.8	50
WABX	Mount Clemens (near), Mich.	1220	246	500
WABY	Philadelphia, Pa.	1240	242	50
WABZ	New Orleans, La.	1090	275	50
WADC	Akron, Ohio	1160	258	500
WAFD	Port Huron, Mich.	1090	275	500
WAGM	Royal Oak, Mich.	1330	225.4	50
WAHG	Richmond Hill, N. Y.	950	315.6	500
WAIT	Taunton, Mass.	1310	229	10
WAIU	Columbus, Ohio	1020	293.9	500
WAMD	Minneapolis, Minn.	1230	244	500
WAPI	Auburn, Ala.	1210	248	1000
WARC	Medford Hillside, Mass.	1150	261	100
WATT	Boston, Mass. (Portable)	1230	243.8	100
WBAA	West Lafayette, Ind.	1100	273	250
WBAK	Harrisburg, Pa.	1090	275	500
WBAL	Baltimore, Md.	1220	245.8	1000

Five

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WMAC	Cazenovia, N. Y.	1090	275	100
WMAF	Dartmouth, Mass.	680	440.9	1000
WMAK	Lockport, N. Y.	1130	266	500
WMAL	Washington, D. C.	1410	212.6	100
WMAN	Columbus, Ohio	1080	278	50
WMAQ	Chicago, Ill.	670	447.5	1000
WMAY	St. Louis, Mo.	1210	248	100
WMAZ	Macon, Ga.	1150	261	500
WMBB	Chicago, Ill.	1200	250	500
WMBC	Detroit, Mich.	1170	256.4	100
WMBF	Miami Beach, Fla.	780	384.4	500
WMC	Memphis, Tenn.	600	499.7	500
WMCA	Hoboken, N. J.	880	340.7	500
WMSG	New York, N. Y.	1410	212.6	500
WNAB	Boston, Mass.	1200	250	100
WNAC	Boston, Mass.	1070	280.2	500
WNAD	Norman, Okla.	1180	254	500
WNAL	Omaha, Neb.	1160	258	50
WNAT	Philadelphia, Pa.	1200	250	100
WNAX	Yankton, S. Dak.	1230	244	100
WNBH	New Bedford, Mass.	1210	248	250
WNJ	Newark, N. J.	1190	252	150
WNOX	Knoxville, Tenn.	1120	268	500
WNRC	Greensboro, N. C.	1340	224	10
WNYC	New York, N. Y.	570	526	1000
WOAI	San Antonio, Tex.	760	394.5	2000
WOAN	Lawrenceburg, Tenn.	1060	282.8	500
WOAW	Omaha, Neb.	570	526	1000
WOAX	Trenton, N. J.	1250	240	500
WOC	Davenport, Ia.	620	483.6	5000
WOCL	Jamestown, N. Y.	1090	275	15
WODA	Paterson, N. J.	1340	224	250
WOI	Ames, Ia.	1110	270	750
WOK	Homewood, Ill.	1380	217.3	500
WOKO	New York, N. Y.	1287	233	50
WOO	Philadelphia, Pa.	590	508.2	500
WOOD	Grand Rapids, Mich.	1240	242	500
WOQ	Kansas City, Mo.	1080	278	1000
WOR	Newark, N. J.	740	405.2	500
WORD	Batavia, Ill.	1090	275	5000
WOS	Jefferson City, Mo.	680	440.9	500
WOWL	New Orleans, La.	1110	270	10
WOWO	Fort Wayne, Ind.	1320	227	500
WPAK	Agricultural College, N. Dak.	1090	275	50
WPCC	Chicago, Ill.	1160	258	500
WPDQ	Buffalo, N. Y.	1460	205.4	50
WPG	Atlantic City, N. J.	1000	299.8	500
WPRC	Harrisburg, Pa.	1390	215.7	100
WPSC	State College, Pa.	1150	261	500
WQAA	Parkesburg, Pa.	1360	220	500
WQAC	Amarillo, Tex.	1280	234	100
WQAE	Springfield, Vt.	1220	246	50
WQAM	Miami, Fla.	1140	263	100

Ten

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WDAY	Fargo, N. Dak.	1150	261	50
WDBE	Atlanta, Ga.	1110	270	100
WDBJ	Roanoke, Va.	1310	229	50
WDBK	Cleveland, Ohio.	1320	227	100
WDBO	Winter Park, Fla.	1250	240	500
WDBZ	Kingston, N. Y.	1290	233	10
WDOD	Chattanooga, Tenn.	1170	256	500
WDRC	New Haven, Conn.	1120	268	100
WDWF	Cranston, R. I.	680	440.9	500
WDZ	Tuscola, Ill.	1080	278	100
WEAF	New York, N. Y.	610	491.5	5000
WEAI	Ithaca, N. Y.	1180	254	500
WEAM	North Plainfield, N. J.	1150	261	250
WEAN	Providence, R. I.	1110	270	500
WEAO	Columbus, Ohio	1020	294	500
WEAR	Cleveland, Ohio.	770	389.4	750
WEAU	Sioux City, Ia	1090	275	100
WEBC	Superior, Wis.	1240	242	100
WEBD	Anderson, Ind.	1220	246	15
WEBE	Cambridge, Ohio.	1280	234	10
WEBH	Chicago, Ill.	810	370.2	2000
WEBJ	New York, N. Y.	1100	273	500
WEBL	United States (portable)	1330	226	100
WEBQ	Harrisburg, Ill.	1330	226	10
WEBR	Buffalo, N. Y.	1230	244	100
WEBW	Beloit, Wis.	1120	268	500
WEBZ	Savannah, Ga.	1140	263	50
WEEI	Boston, Mass.	860	348.6	500
WEHS	Evanston, Ill.	1480	202.6	10
WEMC	Berrien Springs, Mich.	1050	285.5	500
WENR	Chicago, Ill.	1130	266	1000
WEW	St. Louis, Mo.	1210	248	1000
WFAA	Dallas, Tex.	630	475.9	500
WFAM	St. Cloud, Minn.	1100	273	10
WFAV	Lincoln, Neb.	1090	275	500
WFBC	Knoxville, Tenn.	1200	250	50
WFBD	Philadelphia, Pa.	1280	234	5
WFBE	Seymour, Ind.	1330	226	10
WFBG	Altoona, Pa.	1080	278	100
WFBH	New York, N. Y.	1100	273	500
WFBJ	Collegeville, Minn.	1270	236	100
WFBL	Syracuse, N. Y.	1190	252	100
WFBM	Indianapolis, Ind.	1120	268	250
WFBR	Baltimore, Md.	1180	254	100
WFBZ	Galesburg, Ill.	1180	254	20
WFDF	Flint, Mich.	1280	234	100
WFI	Philadelphia, Pa.	760	394.5	500
WFKB	Chicago, Ill.	1380	217.3	500
WFRL	Brooklyn, N. Y.	1460	205.4	100
WGAL	Lancaster, Pa.	1210	248	10
WGBB	Freeport, N. Y.	1230	244	100
WGBC	Memphis, Tenn.	1080	278	10
WGBF	Evansville, Ind.	1270	236	500

Seven

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WBAO	Decatur, Ill.	1110	270	100
WBAP	Fort Worth, Tex.	630	475.9	1500
WBAX	Wilkes-Barre, Pa.	1170	256	100
WBBL	Richmond, Va.	1310	229	100
WBBM	Chicago, Ill.	1330	226	1500
WBBP	Petoskey, Mich.	1260	238	200
WBBR	Staten Island, N. Y.	1100	273	500
WBBS	New Orleans, La.	1190	252	50
WBBW	Norfolk, Va.	1350	222	50
WBBY	Charleston S. C.	1120	268	10
WBBZ	Chicago, Ill. (Portable)	1390	215.7	50
WBCN	Chicago, Ill.	1130	266	500
WBDC	Grand Rapids, Mich.	1170	256	500
WBES	Takoma Park, Md.	1350	222	100
WBNY	New York, N. Y.	1430	209.7	500
WBOQ	Richmond Hill, N. Y.	1270	236	100
WBRC	Birmingham, Ala.	1210	248	50
WBRE	Wilkes-Barre, Pa.	1300	231	100
WBT	Charlotte, N. C.	1090	275	250
WBZ	Springfield, Mass.	900	333.1	2000
WBZA	Boston, Mass.	1240	242	250
WCAC	Mansfield, Conn.	1090	275	500
WCAD	Canton, N. Y.	1140	263	250
WCAE	Pittsburgh, Pa.	650	461.3	500
WCAJ	University Pl., Neb.	1180	254	500
WCAL	Northfield, Minn.	890	336.9	500
WCAM	Camden, N. J.	1270	236	250
WCAO	Baltimore, Md.	1090	275	100
WCAP	Washington, D. C.	640	468.5	500
WCAR	San Antonio, Tex.	1140	263	500
WCAT	Rapid City, S. Dak.	1250	240	50
WCAU	Philadelphia, Pa.	1080	278	500
WCAX	Burlington, Vt.	1200	250	100
WCBA	Allentown, Pa.	1180	254	15
WCBD	Zion, Ill.	870	344.6	5000
WCBE	New Orleans, La.	1140	263	5
WCBH	Oxford (near), Miss.	1240	242	50
WCBM	Baltimore, Md.	1310	229	50
WCBQ	Nashville, Tenn.	1270	236	100
WCBR	Providence, R. I. (portable)	1430	209.7	100
WCCO	St. Paul–Minneapolis, Minn.	720	416.4	5000
WCLO	Camp Lake, Wis.	1300	231	50
WCLS	Joliet, Ill.	1400	214.2	150
WCOA	Pensacola, Fla.	1350	222	250
WCSH	Portland, Me.	1170	256	500
WCSO	Springfield, Ohio	1210	248	100
WCWS	Providence, R. I. (portable)	1430	209.7	100
WCX	Pontiac, Mich.	Now operating with **WJR**		
WDAD	Nashville, Tenn.	1330	226	150
WDAE	Tampa, Fla.	1100	273	250
WDAF	Kansas City, Mo.	820	365.6	500
WDAG	Amarillo, Tex.	1140	263	100
WDAH	El Paso, Tex.	1120	267.7	50

Six

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WQAN	Scranton, Pa.	1200	250	100
WQAO	New York, N. Y.	833	360	100
WQJ	Chicago, Ill.	670	447.5	500
WRAF	Laporte, Ind.	1340	224	100
WRAK	Escanaba, Mich.	1170	256	100
WRAM	Galesburg, Ill.	1230	244	100
WRAV	Yellow Springs, Ohio	1140	263	100
WRAW	Reading, Pa.	1260	238	10
WRAX	Gloucester, N. J.	1120	268	500
WRBC	Valparaiso, Ind.	1080	278	500
WRC	Washington, D. C.	639	469	1000
WRCO	Raleigh, N. C.	1190	252	100
WREC	Coldwater, Miss.	1180	254	10
WREO	Lansing, Mich.	1050	285.5	500
WRHF	Washington, D. C.	1170	256	50
WRHM	Minneapolis, Minn.	1190	252	50
WRK	Hamilton, Ohio	1110	270	100
WRM	Urbana, Ill.	1100	273	500
WRMU	Richmond Hill, N. Y. (portable)	1270	236	100
WRNY	New York, N. Y.	1160	258	500
WRR	Dallas, Tex.	1220	246	500
WRST	Bay Shore, N. Y.	1390	215.7	250
WRVA	Richmond, Va.	1170	256	1000
WRW	Tarrytown, N. Y.	1110	273	500
WSAI	Cincinnati, Ohio	920	325.9	5000
WSAJ	Grove City, Pa.	1310	229	250
WSAN	Allentown, Pa.	1310	229	100
WSAR	Fall River, Mass.	1180	254	100
WSAS	Wooddale, Ill.	1090	275	1000
WSAU	Chesham, N. H.	1310	229	10
WSAX	Chicago, Ill. (portable)	1120	268	100
WSAZ	Pomeroy, Ohio	1230	244	50
WSB	Atlanta, Ga.	700	428.3	1000
WSBC	Chicago, Ill.	1430	209.7	1000
WSBF	St. Louis, Mo.	1100	273	250
WSBT	South Bend, Ind.	1090	275	250
WSDA	New York, N. Y.	1140	263	250
WSKC	Bay City, Mich.	1150	261	100
WSM	Nashville, Tenn.	1060	282.8	1000
WSMB	New Orleans, La.	940	319	500
WSMH	Owosso, Mich.	1250	240	20
WSMK	Dayton, Ohio	1090	275	500
WSOE	Milwaukee, Wis.	1220	246	500
WSRO	Hamilton, Ohio	1190	252	100
WSSH	Boston, Mass.	1150	261	100
WSUI	Iowa City, Ia.	620	483.6	500
WSVS	Buffalo, N. Y.	1370	218.8	50
WTAB	Fall River, Mass.	1130	266	100
WTAD	Carthage, Ill.	1270	236	50
WTAG	Worcester, Mass.	1120	268	500
WTAL	Toledo, Ohio.	1190	252	10
WTAM	Cleveland, Ohio	770	389.4	3500
WTAP	Cambridge, Ill.	1240	242	50

Eleven

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WGBI	Scranton, Pa.	1250	240	10
WGBM	Providence, R. I.	1280	234	30
WGBR	Marshfield, Wis.	1310	229	10
WGBS	New York, N. Y.	950	316	500
WGBU	Fulford-by-Sea, Fla.	1080	278	500
WGBX	Orono, Me.	1280	234.2	500
WGCP	Newark, N. J.	1190	252	500
WGES	Oak Park, Ill.	1200	250	500
WGHB	Clearwater, Fla.	1130	266	500
WGHP	Detroit, Mich.	1110	270	1500
WGMU	Richmond Hill, N. Y. (portable)	1270	236	100
WGN	Chicago, Ill.	990	302.8	1000
WGR	Buffalo, N. Y.	940	319	750
WGST	Atlanta, Ga.	1110	270	500
WGY	Schenectady, N. Y.	790	379.5	5000
WGWY	Minneapolis, Minn.	1140	263	500
WHA	Madison, Wis.	560	535.4	750
WHAD	Milwaukee, Wis.	1090	275	500
WHAM	Rochester, N. Y.	1080	278	500
WHAP	New York, N. Y.	1250	240	500
WHAR	Atlantic City, N. J.	1090	275	500
WHAS	Louisville, Ky.	750	399.8	500
WHAV	Wilmington, Del.	1130	266	100
WHAZ	Troy, N. Y.	790	379.5	1000
WHB	Kansas City, Mo.	820	365.6	500
WHBA	Oil City, Pa.	1200	250	10
WHBC	Canton, Ohio	1180	254	10
WHBD	Bellefontaine, Ohio	1350	222	20
WHBF	Rock Island, Ill.	1350	222	100
WHBG	Harrisburg, Pa.	1300	231	20
WHBH	Culver, Ind.	1350	222	100
WHBJ	Fort Wayne, Ind.	1280	234	50
WHBL	Chicago, Ill. (Portable)	1390	215.7	50
WHBM	Chicago, Ill. (Portable)	1390	215.7	20
WHBN	St. Petersburg, Fla.	1260	238	10
WHBP	Johnstown, Pa.	1170	256	100
WHBQ	Memphis, Tenn.	1290	233	50
WHBU	Anderson, Ind.	1370	218.8	10
WHBW	Philadelphia, Pa.	1390	215.7	100
WHBY	West De Pere, Wis.	1200	250	50
WHDI	Minneapolis, Minn.	1080	278	500
WHEC	Rochester, N. Y.	1160	258	100
WHK	Cleveland, Ohio.	1100	272.6	1000
WHN	New York, N. Y.	830	361.2	500
WHO	Des Moines, Ia.	570	526	5000
WHT	Deerfield, Ill.	1260	238	3500
WIAD	Philadelphia, Pa.	1200	250	100
WIAS	Burlington, Ia.	1180	254	100
WIBA	Madison, Wis.	1270	236	100
WIBG	Elkins Park, Pa.	1350	222	50
WIBH	New Bedford, Mass.	1430	209.7	30
WIBI	Flushing, N. Y.	1370	218.8	50
WIBJ	Chicago, Ill. (Portable)	1390	215.7	50

Eight

CALL SIGNAL	LOCATION	FREQUENCY IN KC.	WAVE-LENGTH IN METERS	POWER IN WATTS
WIBM	Chicago, Ill. (Portable)	1390	215.7	10
WIBO	Chicago, Ill.	1330	226	1000
WIBR	Weirton, W. Va.	1220	246	50
WIBS	Elizabeth, N. J. (portable)	1480	202.6	20
WIBU	Poynette, Wis.	1350	222	20
WIBW	Logansport, Ind.	1360	220	100
WIBX	Utica, N. Y.	1460	205.4	150
WIBZ	Montgomery, Ala.	1300	231	10
WIL	St. Louis, Mo.	1100	273	250
WIOD	Miami Beach, Fla.	1210	247.8	1000
WIP	Philadelphia, Pa.	590	508.2	500
WJAD	Waco, Tex.	850	352.7	500
WJAG	Norfolk, Neb.	1110	270	200
WJAK	Kokomo, Ind.	1180	254	50
WJAM	Cedar Rapids, Ia.	1120	268	100
WJAR	Providence, R. I.	980	305.9	500
WJAS	Pittsburg, Pa.	1090	275	500
WJAX	Jacksonville, Fla.	890	336.9	1000
WJAZ	Chicago, Ill.	930	322.4	1500
WJBA	Joliet, Ill.	1450	206.8	50
WJBB	St. Petersburg, Fla.	1180	254	10
WJBC	La Salle, Ill.	1280	234	100
WJBI	Red Bank, N. J.	1370	218.8	250
WJBK	Ypsilanti, Mich.	1290	233	10
WJBL	Decatur, Ill.	1110	270	500
WJBO	New Orleans, La.	1120	268	100
WJBR	Omro, Wis.	1320	227.1	50
WJBU	Lewisburg, Pa.	1420	211.1	100
WJJD	Mooseheart, Ill.	810	370.2	500
WJR	Pontiac, Mich.	580	517	5000
WJY	New York, N. Y.	740	405.2	1000
WJZ	Bound Brook, N. J.	660	454.3	Varies
WKAF	Milwaukee, Wis	1150	261	500
WKAQ	San Juan, Porto Rico	880	340.7	500
WKAR	East Lansing, Mich.	1050	285.5	1000
WKAV	Laconia, N. H.	1340	224	50
WKBB	Joliet, Ill.	1400	214.2	100
WKBE	Webster, Mass.	1300	231	100
WKBG	Chicago, Ill.	1390	215.7	100
WKRC	Cincinnati, Ohio	920 710	325.9 422.3	1000 }
WKY	Oklahoma, Okla.	1090	275	100
WLAL	Tulsa, Okla.	1200	250	100
WLAP	Louisville, Ky.	1090	275	20
WLB	Minneapolis, Minn.	1080	278	500
WLBL	Stevens Point, Wis.	1080	278	500
WLIB	Elgin (near), Ill.	990	302.8	4000
WLIT	Philadelphia, Pa.	760	394.5	500
WLS	Chicago, Ill.	870	344.6	5000
WLSI	Cranston, R. I.	680	440.9	500
WLTS	Chicago, Ill.	1160	258	100
WLW	Harrison, Ohio	710	422.3	5000
WLWL	New York, N. Y.	1040	288.3	3500

Nine

New 1926-27 Trends in Radio

The "Truphonic" the New Donle Contribution to Better Amplification—New Localized Single Control Overcoming Existing Difficulties—Important Socket Improvements—These Anticipate Trends for the New Trade Year

Reported by DONALD WILHELM

CLEARLY, invention, engineering skill and manufacturing reliability are the factors that have told and will continue to tell Radio's story.

Every year has contributed its bit. The greatest contribution, for instance, of the last year probably consisted of better re-arrangement of parts inside and out of our millions of receiving sets. What improvements and new trade lines will set off 1926-27 from all other years is now the big news. For the technicians have all been hard at work. And the manufacturers are keen to serve the technicians. Heretofore both on occasion have been premature—have been "right" too soon. Obviously, many manufacturers lack the ability and capital to make deliveries in a dependable way. And many more risk patent difficulties that interrupt their plans.

But it is my privilege here and now to announce and to describe the contributions to be made by one company whose prestige and organization were established even before its central loyalties were diverted to radio parts. This company used to have for its slogan when molding insulation to all manner of needs, "You Design It, We'll Make It!" Now its slogan might better be, "We have Designed it—Here It Is!" So, when it makes such an announcement as the following, that announcement is news! In other words, when it devotes its New England plant, its high skill and unfailing facilities to improvements that are revolutionary, the radio public and the radio trade can safely take its accomplishments as final.

It is sufficient to repeat that of course a household word has for years been the word "NA-ALD."

Alden adapters, for instance, have made possible the practical use of power tubes in every vacuum-tube receiver now in use. And, past question, the power tube has afforded the opportunity greatly to improve quality reproduction by increasing gain and cutting down overloading.

Alden sockets and dials—a great family of them answering to an infinitude of uses—likewise long since established themselves as a kind of legal tender in the changing scheme of things.

It can be taken for granted, thus, to go no further, that the Alden Company at Springfield, Massachusetts, having been duly admired for its many efficiencies by such business magazines as *System* and *Factory* has the needed precision and reliability and standing to back up its announcement with deliveries scheduled to a day and hour.

But it needs to be added that this company has not been content with pacing its production to current needs and to limiting its field to areas amply consolidated. In other words, it has brought its established organizing genius to bear on the solution of problems of supreme importance to Radio with the result that its products will undoubtedly occupy larger space than ever on store counters, in wholesale departments and in catalogues, and in the radio receivers made by reputable manufacturers.

In preliminary fashion it is worth pointing out four major new contributions evolved by this company:

I. The Donle Truphonic reflects the interest we all have in improved reproduction. It is synonymous with a new means of amplification certain to have important results in 1926-27.

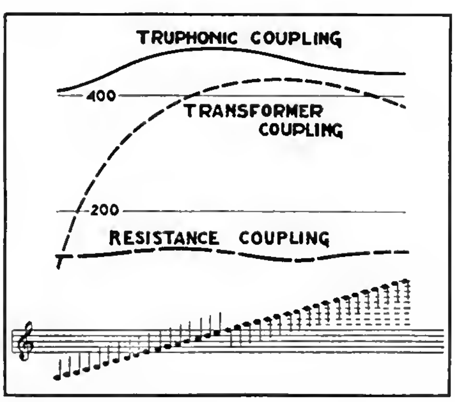


Chart showing superiority of remarkable new "Truphonic" coupling, which gives large and constant amplification over the entire musical scale. From this it will be seen that transformers usually give large but varying amplification, missing the low notes. Resistance gives constant, but small, amplification. While only the improved, Truphonic method has the advantages of both, without their defects, giving large and uniform amplification. Curves show input-output ratio of complete amplifying unit.

II. A new localized control condenser now in production is a sound and ingenious device with many specific advantages, one of which is that it can be operated as easily as one fingers any three contiguous keys on a piano.

III. Another Alden development consists of a new method of gang socket mounting, universal in its application by manufacturers and home-constructors, and economical in cost.

IV. The fourth major Alden development is a new cushion-mounted socket for vacuum tubes. Protected by the earliest patents, it is devised to provide an exclusive means to hold a tube out of physical contact with the base while providing adequate electrical connection.

The large usefulness and detailed advantages of these and other Alden products are of such strategic importance to the radio public and trade at the present time that the following descriptions of their functioning clearly are in order.

I. THE DONLE TRUPHONIC

Transformer, resistance and impedance amplification all have had their innings.

Transformer coupling when of the most costly type is fairly efficient.

Resistance coupling gives, in the opinion of many, the best quality of reproduction, yet it is not particularly efficient, requires extra voltage in B batteries and has the weakness of deteriorating elements.

The impedance coupling, rather expensive, gives markedly better quality than the transformer, being practically equal to resistance.

Now comes a new means of amplification superior to resistance coupling. With three tubes it has an amplification, practically free of all distortion, greater than the best audio transformer amplification with two tubes. This new coupling is so distinctive in performance that it merits a distinctive name—TRUPHONIC.

It is the invention of H. P. Donle, who has more than a hundred inventions to his credit, including the Sodion detector tube, the diamond weave coil and other devices which set this inventor apart as one of the greatest of tube experts.

The Truphonic was the result of definite mathematical calculations extensively tested out.

One of the tests, charted on the preceding page, shows graphically a definite superiority of the Truphonic over any other method of amplification yet evolved. The accompanying chart shows that it gives nearly as flat a characteristic as resistance with none of the objectionable distortion of transformer amplification. Still this chart does not adequately suggest what the Truphonic accomplishes when it is substituted for other couplings in any standard circuit, for the improved quality suggests the subtle but very definite difference that exists between the new Orthophonic and the old Victrola. Therefore it will not be surprising if the Truphonic extensively supersedes all existing forms of audio amplification couplings.

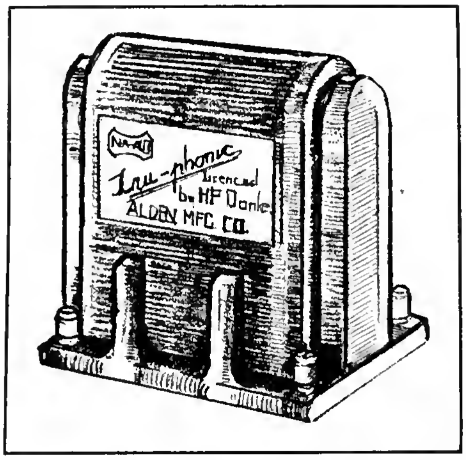
Now, much has been written, of course, on the subject of correct, undistorted or uniform amplification over the entire audio frequency band.

Those who have experimented with resistance amplification know its practical limitations. From a study of curves we know that transformer amplification magnifies the middle frequencies, leaving noticeable weaknesses in the low notes and overtones. Even when these distortions are not audible one has a vague and disquieting sense of the inadequacy of the music or speech rendered. On the other hand, the chart herewith shows the remarkably flat characteristics of the Truphonic, which affords faithful reproduction over the entire musical scale.

And again referring to the chart, one can see that Truphonic amplification gives more gain than resistance amplification. Those most familiar with resistance amplification best know its limitations.

Authorities agree that resistance coupled amplification will not supersede other methods, and call attention to the known fact that the gain per stage with resistance coupled amplification is not sufficient to merit its use throughout the audio end. As a matter of fact many sets designed to utilize the resistance method employ one or more stages of transformer coupling to get the required boost in audio signals.

The Alden Company feels that it is



The Truphonic Amplifier, a great new invention for those who value quality reproduction

safe to predict that in view of the widely recognized inadequacy of audio frequency amplifiers many of the prominent set manufacturers will include the Truphonic in next year's models. The better service given by the Truphonic, its reasonable cost, its longer life and the economy it passes on to the user in lowered battery consumption make the wide popularity of Truphonic amplification a certainty. It requires no additional B batteries, needed in resistance coupled amplification. To put it simply: Its total cost, in view of its merits, is surprisingly low.

Truphonic, for many good reasons, is music up the street of the radio amateur. It affords room for an endless variety of experimentation with hook-ups already in existence. Various circuits which the radio magazines and newspapers have popularized will doubtless be modified to include the Truphonic amplifier. In addition radio writers cannot fail of having their interest evoked with resulting wide publicity.

II. THE NEW NA-ALD LOCALIZED CONTROL UNIT

Single-control tuning so simple that "grandmother can operate it" has long since been an ideal. Practically all the radio engineers in the country have given thought and effort to control so simple that a child might use it in the dark. And 'way back, of course, there appeared on the market various so-called single-control receivers with only one movable dial, though engineers knew that absolute single-control with only one movable dial was still a day dream.

To be sure, many factory-made receivers neat in appearance and featuring only one large dial in the center of the panel were offered to the public. Practice in many instances demonstrated, however, that these receivers, if satisfactory at all, were really controlled not by the "single" dial alone. One or more—and usually more—additional dials or knobs on the panel greatly affected the proper tuning of the set. These smaller knobs were intended to be vernier in their action. In fact they were often critical and hard to adjust. So, to put it simply, usually the so-called single control receiver was found in fact to be harder to operate than the receivers employing two or three dials of large and more convenient size.

The means employed, in the effort to attain single control, were multiple condensers mounted on a single shaft, all moving together, all controlled by a single dial.

The Hogan patent covers this general principle. It is a well-known fact that the method of using multiple condensers mounted on a single shaft involves a necessary compromise between flexibility of control on one hand and the single control idea on the other. Competent radio engineers have recognized the inevitable limitation this method of control puts upon the proper adjustment of the required tuning elements and that, working from this limitation, different compromise arrangements must be made throughout the receiver.

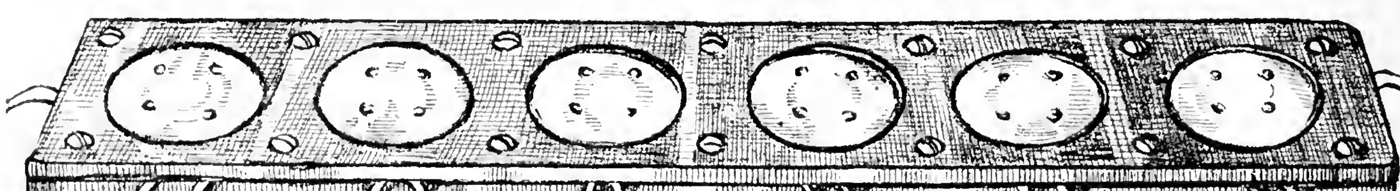
Really, the problem of evolving a simple method of utilizing all the advantages of single control without any of its limitations, still remained.

The Alden Company now believes that it has solved this problem, that its new localized control unit will answer to the large existing need.

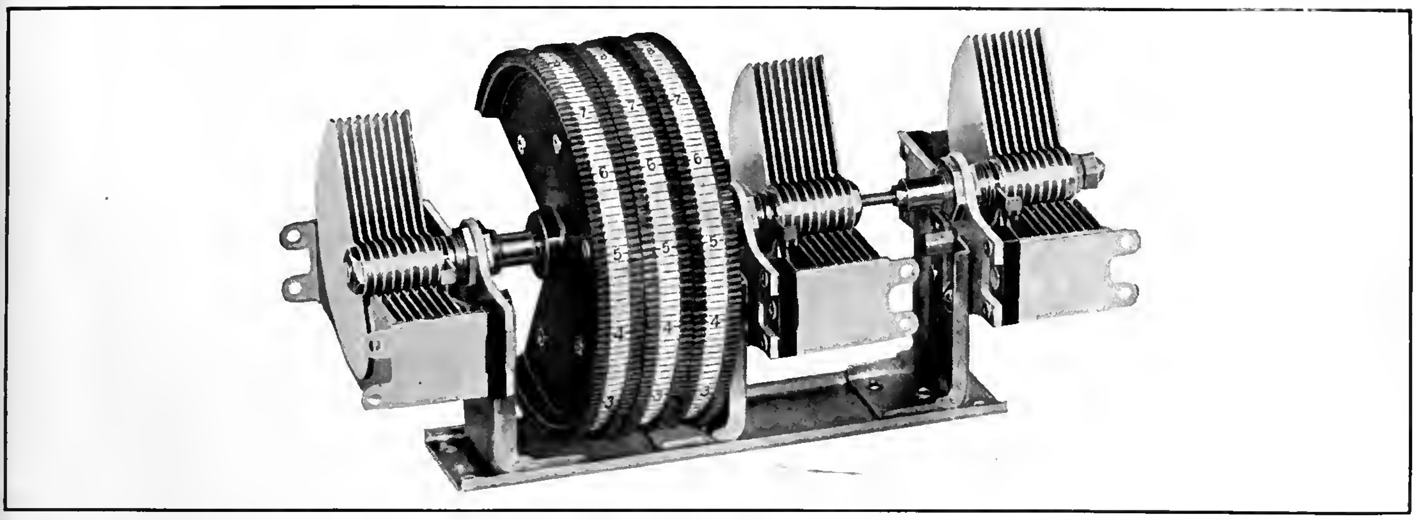
Heretofore the two concentric, independently controlled drums used on the Radiola Super Heterodyne have been the nearest approach to securing the practical benefits of single control without any of its weaknesses.

The Alden unit goes a step further. It employs *three* concentric drums. These overcome one of the disadvantages of the two concentric drums used on the Radiola Super Heterodyne—i.e., they do not stick together and prevent one from moving without the other. Instead, in the Alden unit, each moves freely on its own axis. Yet the three move together when desired as is customary with single-control dials.

This Na-Ald Localized Control Unit



The improved new Gang Socket Mountings are compact and universal in use, taking easily both types of tubes



This amazingly simple tuning device accomplishes all the good of single control, without losing the flexibility of separate controls. There is a drum for each condenser, and each drum moves freely separately, or in unison with the others. Called the "Na-Ald Localized Control Unit," it merits wide popularity among set builders

opens new possibilities for the electrical experimenter and the set manufacturer. It is pleasant for an engineer to realize that he can use three variable tuning controls and still retain all the advantages of single control.

These controlled drums carry a space for logging stations and a convenient means of indicating exact dial locations of stations in kilocycles and meters. The complete Na-Ald Localized Control Unit consists of three separate condensers with three tuning control drums mounted on a suitable bracket, complete and ready for use in building a receiver.

Each condenser is independent, being operated by a separate drum. There is no frictional connection between the drums, so each can be moved freely. This control, being new in its conception and its practical application, does not infringe existing patents on single control of several tuning units. License to use is conveyed by its sale.

The condensers and controlled drums are supported on a rigid metal bracket. The control drums extend beyond the maximum swing of the condensers and pass through the front panel for tuning. Since there is no direct connection to this front panel, the panel itself may be of any material desired—either of wood, of metal or of bakelite.

This unit greatly simplifies set construction. It may be assembled to brackets carrying a gang socket, sub panel or other desired equipment and simple wiring connections with a minimum of soldering. The whole set thus makes a very compact and rugged unit.

The unit, moreover, permits sharp tuning. The diameter of the drums is 4½ inches—made purposely large to facilitate exact tuning. This large size also makes it possible to swing from the highest to the lowest wave lengths instantly, almost without physical effort, by a finger or two.

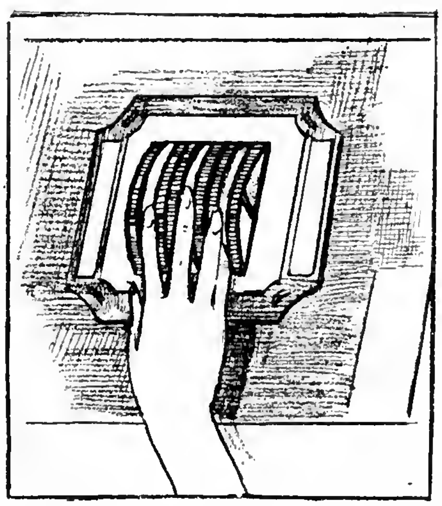
It is also made in a twin-dial model affording two variable tuning elements.

III. THE NEW NA-ALD GANG SOCKET MOUNTING

One of the principal items of labor involved in the construction of a receiver is the placing of tubes with their respective connections. Any improvement in this field clearly has wide application, answers to extensive needs.

Having specialized for years in the manufacture of sockets, it was logical for the Alden Company to devote itself to betterment of sockets with the result that out of its long experience it has evolved for the use of set builders a new gang socket mounting with conclusive advantages over any now on the market.

To begin with, the material and space required for the use of this new socket are reduced to a minimum so that this new Na-Ald mounting is unmatched for both convenience and economy. Further, the Alden Company long back—even before it began to manufacture radio products—were expert in the sound and economical



This gives a general idea of how the Na-Ald Localized Control Unit may be assembled to the panel. Also illustrating the wonderful ease it gives to tuning

production of the materials used for insulation. The laminated material developed for the new gang sockets is therefore molded in accordance with the dictates of long specialized experience, and is produced in a plant equipped for quantity production with a minimum of waste.

More to the point, this improved gang socket is new in principle.

In all set construction gang sockets utilize at least one connection common to each tube. By providing in advance an absolutely universal gang socket the new Na-Ald saves a vast deal of labor in eyeletting and soldering and other means for connection with independent contacts. In other words, the new gang socket provides a continuous strip of conducting metal from one end of the gang socket to the other. Moreover, a second common connector is provided for use in tapping the second filament contacts if desired, and these filament contacts can be tapped separately.

Another attractive feature of this new gang socket is that it takes both the old and the new type of tubes, making it universal in its application.

And in other ways these new Na-Ald gang socket mountings lend themselves to a variety of uses.

They render a positive service to the set builder in anticipating and solving in advance some of the hardest of mechanical and designing problems.

Working from them, since they are the last word in compactness and efficiency, engineers can devote their time and attention to details of greater importance affecting the physical arrangements of the other instruments within the receiver.

For every reason, thus, not the least of which is that the new gang sockets will greatly simplify the work of designers during the coming year, manufacturers and set constructors will welcome these compact and efficient mountings and recommend them as standard equipment.

They provide an attractive, convenient, self-contained unit.

It is to be added that an exceptionally high quality of workmanship is employed, and that all the connections are covered by the insulating material—are protected from dirt and moisture, which cause many sets to become inoperative or inefficient—and qualify under the recent ruling of the Fire Underwriters' Laboratory against exposed live metal connections on current operated sets.

IV. THE NEW NA-ALD CUSHION MOUNTED SOCKET

Radio constructors have long appreciated the advantages of cushion mounted sockets. But it has remained for Alden with its slogan—"It's the Contact that Counts"—to develop a mounting for this purpose that meets all requirements.

This new socket construction, moreover, is protected by the well-known Friedrich patent and others covering the principle of vacuum tubes held out of physical contact with the base by means of contacts which are also the electrical connections. And they also have protection covering the principle of socket construction in which there are openings for the prongs of vacuum tubes with metal strips pressing against the tube prongs, frictionally holding the tube in the socket yet allowing it to be withdrawn.

They take both types of tubes.

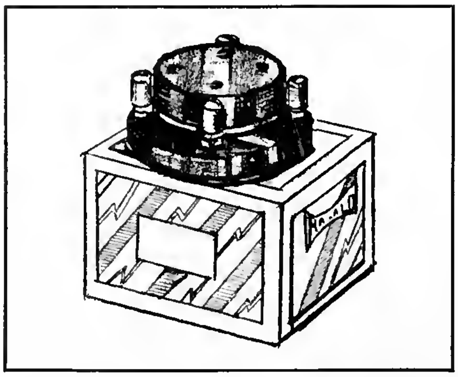
In all respects, therefore, they are as trouble-proof as engineering and productive skill can make a radio part.

THE COMBINED ALDEN LINE FOR ECONOMICAL RECEIVER CONSTRUCTION

These four major additions to the Na-Ald line are only part of the story.

Na-Ald dials, sockets, adapters and connectoralds have for years been legal tender in the radio market. The additions made to these established products, while affecting widely varied radio problems and opening many new opportunities both in engineering and in the manufacture of useful radio equipment, still are closely related one to another. They can be combined effectively.

Many set manufacturers will find that combining two or more of the Na-Ald units will not only effect economies inherent in each unit but will also prove a great labor and worry saver because of their practical interrelation.



A new addition to an illustrious family—the improved Na-Ald Spring Socket—no electrical contact between the tube and the set, other than the grid, filament and plate leads

The Na-Ald gang socket mounting can, of course, be used with the greatest ease for assembly in any equipment desired, but it fits especially well with both (or either) the Donle amplifier and the Na-Ald localized control unit.

A complete receiver using the Na-Ald devices assembles in a space of 7 x 12 inches. This great compactness need not reduce in any way the electrical efficiency of the receiver. Even in this small space there is room to include shielding where desired.

The localized control tuning device, affording the simplest and most perfect tuning control available; the Na-Ald Donle amplifier for the audio frequency end, a distinct advance over all existing methods; and the convenient gang socket mountings all, jointly and separately, adaptable to all standard circuits.

Thus the Alden line, already rich in utilities for set builders, is vastly broadened in its scope, solving in advance many of the knottiest problems of set design and construction.

DON'T OVERLOOK NA-ALD CONNECTORALDS

Of course, everyone—except one or two—has a set nowadays. Most of us have ordinary tubes in our sets, and all of us want the best possible results from our sets. But we all know that ordinary tubes when overloaded cause distortion, and the effect is like that of listening to someone who is overstraining his voice.

To put it simply: Because we all want the best results, and power tubes therefore, thousands have found great satisfaction in using Na-Ald Connectoralds.

To change over, in an instant, from ordinary tubes to power tubes it is only necessary to have on hand only three new parts: a B battery, a C battery and—a Na-Ald Connectorald which is provided with leads to these batteries.

No wiring whatever is necessary.

Produced as they are at low cost, easy to install, definite and certain in their results, Na-Ald Connectoralds were designed for wide use—and have found it.

The demand for them promises to be greater than ever during the coming year. Nearly all set owners want one! Every set dealer needs them—the company itself has had a busy time answering inquiries and getting connectorald shipments out on schedule. And a jobber might as well have a blank page in his catalogue as to fail to reserve ample space for them.

SET BUILDERS CAN COUNT ON ALDEN

A well-known set manufacturer telegraphed an order, recently, for a quantity of Na-Ald dials. Under stress of heavy commitments he wanted them "quick." But he was greatly surprised and pleased to receive his shipment in less than forty-eight hours. And he was even more surprised when he was told that his order was built up from raw materials to finished product in a day.

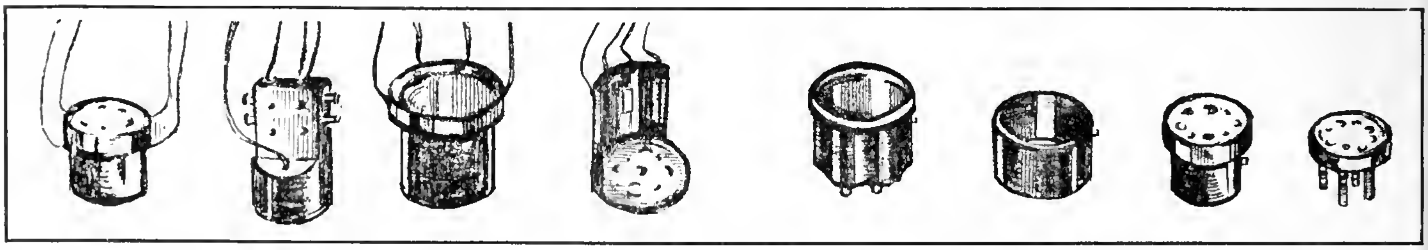
It is a fact that most of the Alden production *is* built up from raw materials to finished products in a day.

It is *paced*—the plant is geared throughout to systematic output typified by mechanical carriers flanked on both sides by swift-fingered girls doing their respective bits. It has a flexible and reliable labor supply. It has advantages in that it has on occasion been able to serve New York City jobbers as promptly as they could be served by New York City manufacturers. And it can supply New England, the Middle West, and the South by truck or express with certainty and speed.

This flexible yet carefully inspected service from a plant so well organized that it has a "vest-pocket shipping room," is without question an asset to the jobber or manufacturer who uses the Alden standard parts in his receivers.

He can bank on the certainty and promptness of Alden deliveries.

And he can bank on Alden financial standing and business methods as well.



Connectoralds and Na-Ald Adapters make possible the use of practically any tube in any set, including the new power tubes which add much power and greatly clarify the outcoming music or speech

B-POWER

By

NOE H. TYAR

In radio we sense a sort of subtle beauty that makes a distinct appeal to the imagination. Even experienced broadcast artists say they never face the microphone without a thrill, a thrill that comes with the realization of the wonderful wizardry of wireless.

No wonder they are willing to give of the best and finest that lie within their power. Surely no voice could be too clear, no note too pure, no harmony too perfect that is to be caught and thrown broadcast to the four winds, broken to a million pieces and each piece captured, amplified and reproduced in nearly instantaneous and perfect accord with the original.

Truly, the folk who work in the studio are living in an atmosphere laden with wonder and romance. But do not all those who come in contact with radio in all of its myriad branches feel the same awe? Does not the set owner experience much the same thrill when he tunes in a station as does the artist at the other end? And how about the men behind the scenes, especially the research workers who have made this marvel possible?

Let us make a visit to the Raytheon laboratory in Cambridge and get acquainted with the men who are actually doing the day by day research that is so essential to progress.

To those who visualize a laboratory as a dusty and cobwebby corner in a dark basement, the first glance in this up-to-date laboratory will be an eye-opener. Instead of some old, wizened, gray-haired eccentric peering through his horn-rimmed glasses at a test tube, we see a dozen bright eyed young men in as many different occupations.

One rather tall, studious looking chap is seen operating a sort of death-defying apparatus that splits the ear with intermittent crackling and hissing sounds. Suppose we investigate and see just what is accomplished by this affront to our ear drums.

Making Experimental Models

Upon approaching as near as seems safe without endangering our lives, we see that he is working on a row of half finished tubes which look very much like the standard Raytheons, with which we are familiar. The six or eight tubes on which he is working are minus the regular brass bases, and up at the top where we are accustomed to see a little glass tip, we now find long glass tubes which run up to an intricate system of glass piping.

Among the network of fragile glass tubing which composes this system, we see large glass bulbs supposedly filled with rare gases, queer looking mercury gauges which resemble huge thermometers bent all out of shape, and a swift running vacuum pump that pounds away doggedly in apparent disregard of the fact that nature abhors a vaccum. We turn to our complacent guide who assures us that the apparatus is simply a system to make up tubes for experimental purposes.

It seems that the building up of satisfactory gaseous rectifier is a rather complicated process. Among the most important of the operations is the one of "bombarding" which attracted our attention due to its ear-splitting noise. "Bombarding" a tube means that it is subjected to extremely powerful high frequency currents having a frequency of several million cycles per second. This brings the metal parts of the tube to a brilliant orange-white heat that drives whatever residual gases may have been in the metal out into the tube so that the vacuum pump may draw them out through the exhaust.

The bombarder is quite a heavy and complicated looking piece of apparatus which can be moved around the floor on wheels, but the active element which is used to heat the tube is simply a small coil of about 3" in diameter and a dozen turns. When the high frequency currents are running through this coil it will rapidly heat up any piece of metal which is held near it; glass, paper or even a match would keep quite cool even when put on the inside of the coil due to the fact that these articles are not good conductors.

After each of the several tubes in the process has been bombarded four times, the engineer adjusts several of the various stop-cocks in his system of glass tubing and we learn that he is now letting the desired amount of pure gases into the tubes. After this operation he directs the flame from a blow torch at the top of each bulb where it is joined to the tubing, and with a dexterous sweep of the wrist removes each finished tube with its vacuum tight tip carefully sealed by his torch.

"What will be the fate of these new rectifiers?" we ask, rather hoping that

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we have witnessed the first of a new line of Raytheon tubes which would some day revolutionize the radio market. Of course there is the possibility, it seems, but these are merely a half dozen of a thousand different models that have been made up and put to almost as many different tests during the past few months. From each experimental model some little detail is learned that helps in the production of Raytheons of greater ruggedness and reliability. But the fundamental and basic principle upon which rectifiers operate have been known for a long time and no revolutionary change in these principles can be expected.

Research, and Research Workers

Now let us take a look at some of the other activities. To investigate and understand them all would requre more time than is at our disposal, but we may at least get a smattering of what it is all about.

Out in one of the smaller rooms we find what looks like the realization of a radio experimenter's dream, with a few chemicals, a delicate balance scale, and other nameless apparatus thrown in for good measure. Over in an alcove we see a desk and table, and seated there two engineers earnestly discussing a sheaf of papers covered with figures and rough diagrams. It is here, we learn, that the fundamental work on the phenomena of gaseous conduction is done; work that may have no immediate value but yet is blazing the trail for the practical applications in the years to come. From the studies made here will come new applications of filamentless rectifiers in far different fields from those in which they are now recognized as leaders.

We are now introduced to the dark "sanctum sanctorum" where the glass blower does his work. He likes to have just the right amount of darkness so he can tell by changing colors of the glass just when it is ready for manipulation into some of the intricate bends and bulbs that are constantly in demand. A slight draft of air might have a bad effect on both the temper of the glass and the glassworker, so we close the door quietly and proceed.

Out in the main room again we see a whole wall dotted with rectifier bulbs mixed with carbon lamps, all lighted to various degrees of brilliancy. It is here that the experimental models are put through their final test, a life test

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under heavy load to see how they will stand up in service. And it is on this test more than any other that the work of the laboratory staff is judged.

Upon taking an inventory of the laboratory personnel, we find that one man is a physicist of ten years' experience on gaseous conduction problems, five of these years in graduate work at Harvard University. Another is a professor of electrical engineering at M. I. T., in charge of graduate research at that Institution. Three of the staff are graduates of the same school with the degree of Master of Science, and three others are engineering graduates. Many of the practical production problems are solved by John A. Spencer, inventor of the Spencer "Click" Thermostat now used in automatic electric irons. Of equal ingenuity is his brother, P. L. Spencer, who has had many years of practical radio experience with the Wireless Specialty Company and the Submarine Signal Company. A competent and serious group of men is this. To know that they are devoted to but one main problem, the proper application of A. C. power to radio receivers, gives one confidence. But let us resume the rôle of observer, since we came to learn.

Maintaining B-Power Quality

Over here at another bench we see a young fellow putting a finished B-power unit through its paces. This seems rather strange since we understood that the Raytheon Company made nothing but the rectifier tube. And yet in a large steel cabinet near this bench we see some 15 or 20 B-power units of all shapes and sizes, some with meters, knobs, switches and taps and others with plain metal sides with the barest minimum of taps and controls. These units have been made by various manufacturers and they have been submitted for test and approval by the Raytheon laboratory.

The standard test consists of (1) measuring the output voltage at various loads on the detector, radio frequency and audio frequency taps; (2) detecting any hum or noises that may exist at any of the above loads on a sensitive electrical circuit; (3) testing the reliability of the controls and switches; (4) testing the condensers with several times the normal operating voltage to make sure of their ability to stand up in service and (5) a general inspection and test of the

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RAYTHEON

durability and quality of all parts used in the construction.

Let us stop for a moment to consider what this means to the average radio fan who has no laboratory facilities of his own to make such tests before selecting a B-power unit. It means that he now has a standard upon which he can rely. Of course different units will have different features and prices, backed as they are by many manufacturers in different parts of the country, but the buyer has the satisfaction of knowing that any Raytheon unit will do the job for which it is designed and rated. This is true not only of the complete units, but of the separate parts for home built units which have been tested and approved in the Raytheon laboratories.

In other words, there is one branch of the radio industry in which all products must reach a certain standard of performance before they are offered to the public. Not only does the Raytheon Company maintain rigid test and inspection of its own product, the rectifier tube, but it actually goes so far as to protect the consumer who buys a B-power unit using that tube.

The Raytheon Policy

The full significance of this policy and how it is carried out is not appreciated without some thought. One question that immediately arises is, "What prevents any manufacturer from putting out a Raytheon B-power unit, without having it tested and approved by the Raytheon laboratories?" In the first place any manufacturer of standing who values his reputation is glad to have his product tested by specialists who can offer suggestions as to its improvement. The reliable Companies do not wish to put out a unit that would not pass the most severe tests. They welcome this service by an unprejudiced organization.

If there are Companies who do not see the wisdom of this policy the Raytheon Company exercises its privilege of protecting the consumer by refusing to sell tubes to the offender. Even the most intrepid "bootlegger" would hesitate to put out a Raytheon B-power unit minus the tube and against the competition of approved units. All Raytheon tubes are sold through the Manufacturers of approved B-power units. In buying the complete unit with the Raytheon tube satisfaction is assured.

Advertisement

Reliable Performance Always

Every baseball team has its "pinch hitter." He's the man who can step up and *perform* under any circumstances. And that is the way you learn to feel about your radio when it is equipped with a Majestic Super-B.

You get fine, clear tone in plenty of volume under all sorts of receptive conditions. The cost of operating your set, too, is reduced to the infinitesimal tenth of a cent an hour.

When you consider these advantages you will realize why engineers and technical experts who *know* radio equipment specify the Majestic Super B. Its technical superiorities are: Two chokes of 41 Henrys each and 20 microfarads of capacity in the filter circuit. The use of 30 gauge wire of low resistance for winding the chokes and transformer also permits voltage regulation of better control. Unusually large condenser bank smooths out every trace of ripple with a wide safety factor to spare.

Majestic Super-B Current Supply, complete with Raytheon Tube, capacity 1 to 12 tubes, including the use of new 135-150 volt power tubes.
110 volt, 60 cycle. Price $39.50

The Majestic Standard-B is a smaller B current supply unit, designed for sets having not more than 6 201A-type of tubes or 5 201A, plus one 112 type of 135-volt power tube.

Majestic Standard-B Current Supply, complete with Raytheon Tube. 110 volt 60 cycle. Price $32.50

GRIGSBY-GRUNOW-HINDS CO. ★

4550 Armitage Ave. Chicago, Illinois

RAYTHEON

The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have heretofore been answered either by letter or in "The Grid." From this issue on, however, the latter department will be discontinued, and all questions addressed to our technical service department will be answered by mail. In place of "The Grid," we present herewith the first of a series of Laboratory Information Sheets. These sheets will contain much the same type of information as has appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater inter est to our readers.*

The Laboratory Information Sheets will cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the ma gazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are referred to page 175, *where it is explained in detail.*

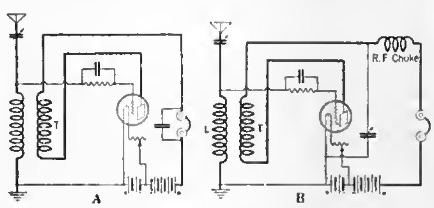
No. 1 RADIO BROADCAST Laboratory Information Sheet June, 1926

Regeneration

METHODS OF CONTROL

WHEN radio waves of the frequency to which the antenna circuit is tuned are being received the high frequency currents flowing in the coil produce high frequency variations in the grid potential which, in turn, produce high frequency currents (of considerably greater energy) in the plate circuit. If we could "feedback" some of this plate energy to increase the original potential applied to the grid, it might help to increase the original potential applied to the grid. This can be done in several ways. A very common method is shown in A.

The essential addition to the circuit is the coil in the plate circuit. This is called the "tickler" coil, and upon being brought up near the antenna coil its mutual inductance, or transformer action, affords a means by which energy from the plate circuit is fed back into the antenna circuit. The tickler must be connected the right way too, for if the connections are reversed its effect will be to reduce the antenna current instead of increasing it. If the coils are brought too close together, a point will be reached where more power is being fed back to the antenna circuit than is being dissipated therein. The tube is then said to be oscillating, and will continue to oscillate even if the radio waves cease coming in. The loudest signals are obtained just before the tube "breaks into oscillation." Signals can be received even while the tube is oscillating if the oscillation frequency is kept exactly the same as the carrier-wave frequency.



There are several methods of controlling feed-back, either by a variable tickler as in A or by a variable resistance shunted across a fixed tickler coil. Another method is by the use of a variable condenser, as illustrated in B.

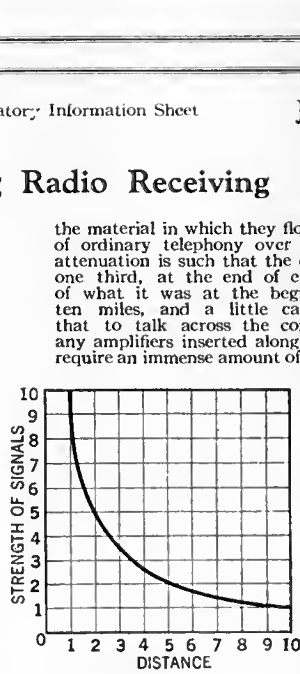
No. 2 RADIO BROADCAST Laboratory Information Sheet June, 1926

Factors Governing Radio Receiving

HOW THEY AFFECT DISTANCE

THERE are three main factors governing the distance that can be satisfactorily covered between a given transmitting station and a given receiving set. These can be stated as follows:

1. The amount of interference.
2. The inverse distance effect. As the radio waves spread out in all directions from the transmitting station their strength naturally decreases. At twice the distance, their amplitude is halved; at four times the distance, it is only one quarter, etc. This same fact could also be expressed by saying that the strength of the signals is inversely proportional to the distance. A curve illustrating this is shown in the accompanying diagram. The curve is based on ideal conditions, and neglects absorption by buildings, fading, etc.
3. The attenuation, which is quite a different thing. It acts simultaneously with the inverse distance effect to reduce the amplitude of the waves. Attenuation of the waves is due to their being dissipated in the form of heat. Whenever the waves strike any object in which they can produce electric currents, the currents are produced at the expense of the energy of the waves and heat up, to a minute degree, the material in which they flow. In the case of ordinary telephony over land wires, the attenuation is such that the current is about one third, at the end of every ten miles, of what it was at the beginning of those ten miles, and a little calculation shows that to talk across the continent without any amplifiers inserted along the line would require an immense amount of power. Yet, by the insertion of fifteen amplifiers or relay stations along the line, the attenuation law is prevented from "getting under way," and a ridiculously small power is enough for proper transcontinental land line telephony.



Excerpts from Telegrams:

"Tested your RFL-60 within two blocks of local 500-watt broadcasting station, using twenty-five foot wire on floor for aerial. We picked up stations all over the country and when local station came in tuned it out and picked up WSAI at 319 meters. The local station is 270 meters. This is the only set ever tested under these conditions that would tune this station out at any point on dials."—Decatur, Ill.

"We tested one of your new RFL-60 sets here in our building using an antenna about 75 feet long and directly under and parallel with our transmitting aerial. The exceptional selectivity of the Crosley receiver permitted us to tune out our station WTAX, just as easily as we would tune out a Chicago station."—Streator, Illinois.

"An RFL-60 tested in competition with other receivers of much higher price proved its unquestioned superiority. The new Crosley models offer the greatest values on the radio market."—Kansas City, Mo.

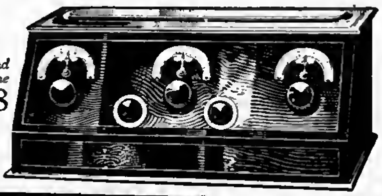
"The Model 4-29 is classed with the Trirdyn. Model 5-38 bringing in Pacific points with ample volume, using a Musicone. RFL-60 and 75 are very selective. Have separated distant stations on less than one degree on the dial. Have logged Mexico City and Pacific Coast Stations with plenty of volume."—Miami Fla.

"The RFL sets outstripped much higher priced outfits. These sets bring in Canadian, Cuban and Mexican stations as easily as those on nearby states."—Glasgow, Ky.

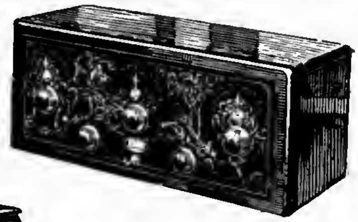
What's the idea of keeping a fellow up all night foolin' around with that darned little 4-29?

I've been in the radio game for seven years and was beginning to believe that there wasn't a set in the world that would keep me up late but when that little 4-29 started to pull in Houston, Texas and with such extreme volume I sat up and took notice.

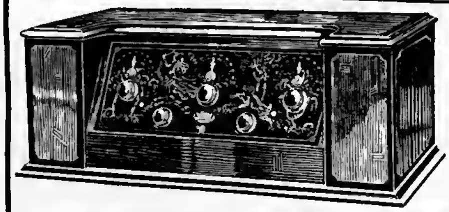
I got California stations with unbelievable volume last night. KFI came in so loud that it could be heard over a block on a Musicone speaker. I've gotten over one hundred and twenty-five stations in only three nights.—Spring Valley, Ill.



The Crosley 5-tube—5-38
All the volume, selectivity and purity of tone available in the best 5-tube set—plus the Crescendon $38



The Crosley 5-tube—RFL-60
A set of marvelous performance and beautified by the artistic decorative panel $60



The Crosley 5-tube—RFL-75
Simplicity and speed in tuning, fidelity of tone and decorative beauty, enhanced by the art panel $75

The Crosley 4-tube—4-29
In which the Crescendon is equal to one or more additional tubes of tuned radio frequency amplification $29

Prices slightly higher west of the Rockies

By Expressed Opinion of Fans The Greatest Radio Values Ever Offered!

Real performance! Amazing sensitivity and selectivity! Marvelous tonal qualities—inspiring volume. And surpassing beauty!

Read, in the column at the left, the enthusiastic comments of a few of the many radio fans who have *voluntarily* written or wired us their praise.

True radio values—at astonishingly low prices. Hear a Crosley Concert at your nearby Crosley dealer's.

For descriptive catalog write Dept. 20

THE CROSLEY RADIO CORPORATION, CINCINNATI, OHIO

Powel Crosley, Jr., President

Owning and Operating WLW, first remote control super-power broadcasting station in America

CROSLEY

BETTER · COSTS LESS

RADIO ★

for the Entertainment Corner

Manufactured under Armstrong U. S. Patent No. 1,113,149, or under patent applications of Radio Frequency Laboratories, Inc.

No. 3 RADIO BROADCAST Laboratory Information Sheet June, 1926

The Browning-Drake Receiver

ON SHEET No. 4 is shown a diagram of the popular Browning-Drake receiver, which, in its improved form, was fully described by Glenn H. Browning, one of the designers, in the December 1925, RADIO BROADCAST. The first article appeared in this magazine for December, 1924. Three stages of impedance-coupled audio amplification are employed in this circuit. The constants of the circuit as shown, are as follows:

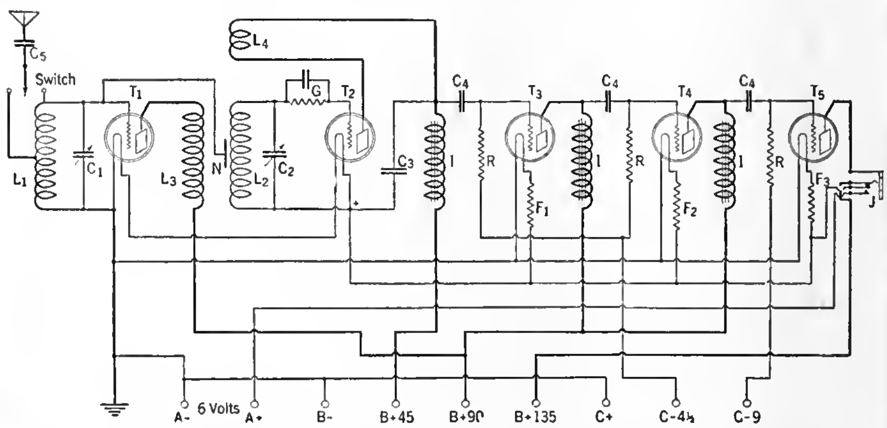
C_1—.0005-mfd. variable condenser.
C_2—.00025-mfd. variable condenser.
C_3—.00025-mfd. fixed condenser.
C_4—0.1-to 1.0-mfd. fixed condenser.
C_5—.0001-mfd. fixed condenser.
L_1—46 turns No. 20 d.s.c. wire on a form 3 inches in diameter, with a center tap.
L_2—75 turns No. 20 d.s.c. wire on a 3-inch form.
L_3—24 turns No. 28 d.c.c. wire wound in a groove and placed under the filament end of the secondary.
L_4—20 turns No. 28 d.c.c. wire wound on a 2½-inch form to fit in grid end of secondary (L_2).
I —100-henry choke coils.
R —1-megohm grid leaks.
N—Neutralizing condenser, consisting of a small brass disc about an inch in diameter, mounted so as to make its position, in relation to L_2, variable.
F_1, F_2, F_3,—Fixed filament control resistances to match the type of tubes employed.
J —Single-circuit filament control jack.
G —.00025-mfd. grid condenser and leak (6-megohm).
T_1, T_2,—Two UV-199 tubes.
T_3, T_4,—Two UV-201-A or High-mu tubes. If the latter are used, F_1 and F_2 may be omitted.
T_5,—Semi power tube.

Although choke-coupled amplification is shown in the diagram, the circuit may be used just as well with transformer or resistance-coupled audio stages. If the transformer-coupled form of amplification is desired, only two stages will be necessary for average requirements.

The center tap is employed on the antenna coil for use when one's antenna is in excess of 100 feet in length, but it is advisable to employ a single-pole double-throw switch at this point so that either antenna connection may be used without undue changes being necessary. The reason for this is that the capacity of the antenna has to be taken into consideration as well as its length.

No. 4 RADIO BROADCAST Laboratory Information Sheet June, 1926

The Browning-Drake Circuit



Complete data, on the sizes of the various units, used in this circuit appear in Sheet No. 3

No. 5 RADIO BROADCAST Laboratory Information Sheet June, 1926

Transformers

PRIMARY-SECONDARY RATIOS

THE ordinary commercial iron-core transformer consists simply of two coils of wire wound on the same core. So long as the secondary of such a transformer is open circuited, or connected to something with an impedance so high that not much current flows, we have a very simple relation between the voltage delivered by the secondary and that applied to the primary. This relation states that the ratio of these two voltages is the same as is the ratio between the primary and secondary turn numbers. A ten to one step-up transformer would be one with ten times as many turns on the secondary as on the primary.

A transformer corresponds to gears in mechanics. If by an arrangement of gears or levers we increase a mechanical force ten times, we know instinctively that we must expect the part of the arrangement that is exerting the "stepped-up" force to move ten times as slowly as the part where the original force is being applied. If we choose to gain in force, we lose correspondingly in speed, or else we could get "something for nothing." The electrical transformer is not a source of power. It merely changes the power put into it at one voltage into the same power (with a small percentage loss) at a different voltage. Hence, just as the speed went down in the mechanical case, so the current is less in the high tension or high voltage side of the transformer. The primary current is related to the secondary current as the secondary voltage is related to the primary voltage. An auto transformer is no different except that the winding having the fewest turns is merely a part of the other winding. Thus only one coil is required.

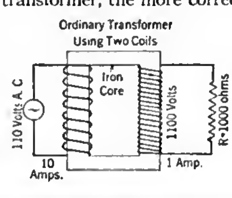
There are several simple formulas regarding transformers that are quite useful:

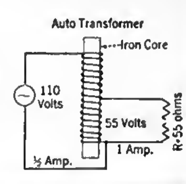
$$\frac{\text{Primary Turns}}{\text{Secondary Turns}} = \frac{\text{Primary Voltage}}{\text{Secondary Voltage}}$$

$$\frac{\text{Primary Turns}}{\text{Secondary Turns}} = \frac{\text{Secondary Current}}{\text{Primary Current}}$$

$$\frac{\text{Primary Voltage}}{\text{Secondary Voltage}} = \frac{\text{Secondary Current}}{\text{Primary Current}}$$

Values obtained by the use of the above relationships will serve as fairly close approximations. In general, the smaller the load being supplied by the transformer, the more correct this data will be.





★ Tested and approved by RADIO BROADCAST ★

No. 6 RADIO BROADCAST Laboratory Information Sheet **June, 1926**

Dielectric Constant

ITS EFFECT ON CONDENSER CAPACITY

THE capacity of a condenser depends upon several different factors, the most important of which are:—1. Area of plates; 2. Number of plates; 3. Distance between plates; 4. The dielectric or insulating material between plates.

The effect of the first three quantities on the capacity is easily calculated by means of formulas based on theory, but in order to determine the effect of the dielectric, it is necessary to conduct actual tests using different materials.

The commonest dielectric used in variable condensers is air, and its dielectric constant, or specific inductive capacity, is unity. For fixed condensers, one of the best dielectrics is mica, and it is used on practically all small fixed condensers for radio use, because of its low losses. When a voltage is impressed across a condenser, a certain amount of energy is consumed in the dielectric, and the smaller this energy loss, the better is the condenser. For the larger condensers, of one or two microfarads capacity, oiled paper is generally used. Its use helps to reduce the cost and the break-down voltage of such a condenser will be greater than if plain paper is used.

Solid dielectrics have the disadvantage that if they are once broken down and punctured, due to excessive voltage, they are rendered useless. However, if a liquid dielectric is used, this disadvantage cannot exist, and for this reason laboratory condensers of fairly large capacity quite frequently use castor oil as the dielectric. In this way it is not only possible to obtain variable condensers with a fairly large capacity (the capacity of any given condenser by the use of castor oil is made five times as great as it would be if air were used), but it is also possible to apply greater voltages without sparking between plates. The capacity of any given condenser is proportional to the constant of the dielectric that is used.

Some of the most common materials used as dielectrics are listed in the table given herewith.

Vaseline	Ebonite	Glass	Mica	Paraffin Wax	Porcelain	Quartz	Resin	Shellac	Castor Oil	Olive Oil	Petroleum Oil
2.0	3.0	7.0	6.0	2.5	4.0	4.5	2.5	3.5	5.0	3.0	2.0

No. 7 RADIO BROADCAST Laboratory Information Sheet **June, 1926**

The New Tubes

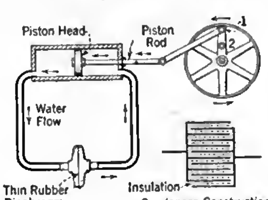
Type	A Battery Volts Supply	Filament Terminal Volts	A Battery Current (Amperes)	B Battery Volts, Detector	B Battery Volts, Amplifier	Negative C Battery	Plate Current (Milli-amperes)	Output Resistance (Ohms)	Voltage Amplification Factor
UX-199	4.5	3.0	.06	45	90	4.5	2.5	15,000	6.25
UX-200	6	5	1.0	15 to 25	—	—	—	—	—
UX-201-A	6	5	.25	45	90 135	4.5 9.0	3 4	12,000 11,000	8 8
WX-12	1.5	1.1	.25	22½	90	4.5	2.8	14,000	5.6
UX-112	6	5	0.5	22½ to 45	157 135 112 90	10.5 9.0 7.5 6.0	7.9 5.8 2.5 2.4	4800 5500 8400 8800	8.0 7.9 7.9 7.9
UX-120	4.5	3.0	.125	—	135	22.5	6.5	6600	3.3
UX-210	8 6	7.5 6.0	1.25 1.1	— —	425 350 250 157	35 27 18 10.5	22 18 12 6.0	5000 5100 5600 7400	7.75 7.65 7.5 7.5

No. 8 RADIO BROADCAST Laboratory Information Sheet **June, 1926**

Condensers

A SIMPLE EXPLANATION OF CONDENSER ACTION

THE accompanying diagram shows the construction of a condenser, and also a simple analogy for its action. The crank and piston arrangement, when rotating, produces an alternating current of water which fills the system. A thin rubber diaphragm prevents any direct circulation, but, by bending back and forth, allows alternating motion of the water. The greater the area of the diaphragm, the thinner it is, and the more flexible it is, the easier it will be to turn the crank to operate the piston. If (refer to the diagram) the piston connecting rod is hitched to point No. 2 on the drive wheel instead of No. 1, only half the force will be required to turn the crank, as the diaphragm will only be stretched half as much. Also, the current will be only half as great. But if, then, the crank be turned twice as fast, the speed of the water will be doubled so that the current is the same as before. This establishes a relation that holds good in the electrical case, namely, that if the frequency be doubled, or trebled, etc., the electromotive force required to produce the same current will be only one half, or one third, etc., as great. In the electrical case, corresponding to the diaphragm we have a sheet of some insulating material (dielectric) separating the two sheets, or sets of sheets, of the condenser. By increasing the area of the metal plates, thinning the insulating material (this corresponds to decreasing the spacing between the plates), or employing dielectric with a high "constant" (see Laboratory Sheet No. 6), the value of the applied voltage to produce a given current is proportionally decreased. Fixed condensers usually consist of metal foil cut up into small pieces which are connected together, and separated with mica or some other dielectric. There are two distinct sets of plates, corresponding to the rotor and stator plates of a variable condenser. The "capacity" of condensers used in radio circuits is usually expressed in microfarads, and if air is used as the insulating substance between the plates, the capacity in microfarads is approximately equal to the area of one of the plates (measured in square centimeters) divided by 11,300,000 times the distance between the plates (measured in centimeters). If other insulating material is used, it is necessary to multiply by its dielectric constant. The dielectric constant of mica, for example, is about 6.



From this explanation it is evident that current never actually flows through a condenser, but that it merely, we might say, collects on the condenser plates, and then returns back to the starting point.

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prizewinner for the last period was announced in the May Radio Broadcast. *Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* Radio Broadcast, *Garden City, New York.*

A WOODEN STAND TO HOLD A MACHINIST'S DRILL

THE amateur mechanic, interested in obtaining additional service from a limited number of tools, will find in the wooden stand fixture illustrated in Fig. 1, a means for obtaining a wide extension of use from the hand type of machinist's drill.

With this fixture, and a hand drill secured to the frame structure, it is possible to do drilling work with great facility and accuracy. Drilling glass, deep drilling in steel, cutting with an expanding type of drill, and similar jobs requiring care and patience, are possible with this form of drill fixture.

The same fixture also permits of holding work horizontal, through tilting of the drill frame. This position enables small parts to be turned up from pieces of brass and steel rods, with a file for a cutting tool.

The merits of this stand will be evident to the user of the drill, but a main feature is the simplicity of its construction. A drill support block, A, is the means for holding the drill and permitting of its being moved endwise. Two guide blocks, B-B (into which A slides) are attached to an arm, C, extended outward from a vertical support, D. A single large wood block, E, forms the base. The base is hinged to the work-bench or other base by ordinary strap hinges, permitting of the entire structure being tilted.

Screws secure the several pieces of wood forming the frame, making a fixture that is readily fitted up in an hour or so, with only wood-working tools.

The dimensions, as will be evident from the drawing, will vary with the size of drill available.

George A. Luers,
Washington, District of Columbia.

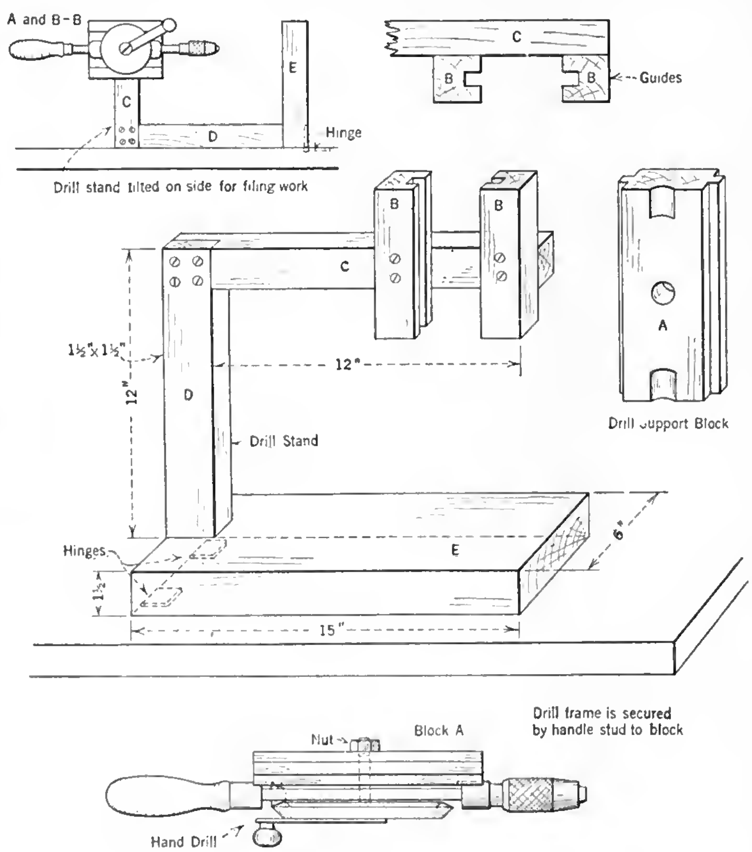


FIG. 1

A SIMPLE CONE LOUD SPEAKER ALTERATION

CONE speakers sometimes develop a buzz or rattle that cannot be overcome by ordinary mechanical adjustment. This will be especially noticeable on fairly weak volume, causing a blurring of voices. A practical and proven remedy is to apply a small daub of rubber cement of the sort that remains semi-flexible after drying thoroughly, around the needle shaft actuating the instrument, at the point of its connection with the cone tip. On the front side, back off the small nut on the shaft end enough to allow the cement to coat its surface, and dry before tightening the nut, forming thus a rubber washer. After tightening the nut, apply one more coating of cement over the nut and shaft end. Do not tighten the nut more than necessary, otherwise you are liable to cut through the first coating.

Glue will work satisfactorily for the volume usually required for best reproduction with cone speakers, but rubber cement is superior when low volume is desired.

A. H. Klingbeil,
Ashtabula, Ohio.

A WINDING FORM FOR LOW LOSS COILS FOR THE ROBERTS SET

THE winding form described below was used to make several sets of low loss coils for the Roberts hook-up and was found to work very nicely.

LIST OF MATERIAL REQUIRED

A piece of hardwood $2\frac{1}{4}$ inches in diameter and $1\frac{1}{2}$ inches thick.

An $\frac{8}{32}$ machine screw $1\frac{3}{4}$ inches long, with nut.

Thirteen pins $\frac{3}{16}$ x 4 inches long

Take the piece of hardwood and lay out 13 holes around the circumference $\frac{3}{4}$ inch from the edge. See Fig. 2. Drill a $\frac{3}{16}$-inch hole at each of the 13 points radially with the center. Now drill a hole at right angles to the thirteen holes, through the center, using a No. 18 drill. Then put the block in a vise and saw in half on the center line used to lay out the thirteen holes. After sawing clean up all the rough edges with a sharp knife or file; also put an assembly line, A, Fig. 2, on the edge so that the blocks will be assembled the same way each time. The form is now ready for use.

Put the blocks back together using the $\frac{8}{32}$ machine screw and nut to hold them; then insert the thirteen pins and tighten up the machine screw until the pins are all securely held in place. Wind the coil by going over two then under two pins until the required number of turns are in place. Now remove the machine screw and take the two halves of the block apart and you are ready to fasten the windings.

Weave cord through them, threading it in between the cross wires, removing the

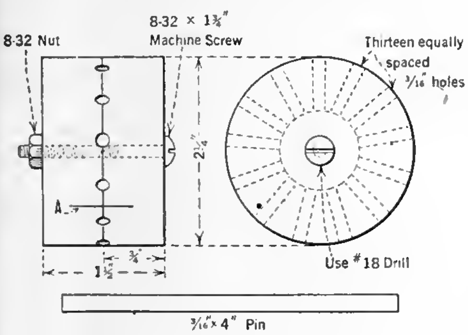


FIG. 2

pins one at a time after the wires are securely tied at each pin.

You will now have a self-supporting low loss coil, with only a small amount of cord holding it in place.

ARTHUR W. SMEALLIE,
Scotia, New York.

AN IMPROVED RADIO REPRODUCER

AT THIS time, when everyone is devoting energy to obtaining better quality of reproduction from his radio receiver, it seems proper that I should mention a new type of radio reproducer which I have developed for my own use. The quality of reproduction is wonderful because high and low notes are reproduced alike. The tone resembles that of the new "Orthophonic" Victrola, and the volume may be regulated by the volume adjuster on the phonograph. The diagram, Fig. 3, clearly shows the general idea of the reproducer.

I would suggest that a unit of good quality be used and that it be adjustable. Proceed as follows: Unscrew the cap of the loud speaker unit and lay the diaphragm, face up, on the table. In the exact center scrape the lacquer off and solder a 3-inch length of No. 14 wire. Make sure that the wire is in the exact center and perpendicular to the diaphragm.

Now replace the diaphragm and tighten the cap on the unit. With a pair of pliers bend up a half-inch length of the wire as shown in the diagram.

Next the unit should be connected to the phonograph. It may be used with any

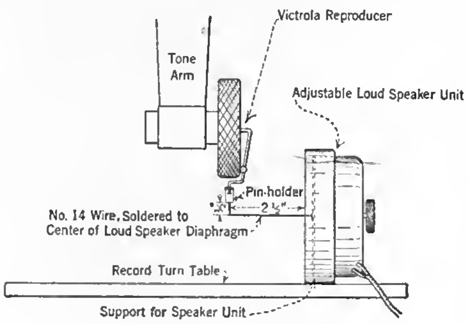


FIG. 3

make of phonograph providing that it is placed parallel with the reproducer on the phonograph; that is, so that the diaphragm in the loud speaker is parallel with that in the phonograph reproducer.

The loud speaker unit should rest on the turntable of the phonograph in a position so that the wire will fit into the needle receptacle of the phonograph reproducer. Next tighten the thumbscrew, holding the turned-up end of the loud speaker wire firmly in the needle receptacle.

With this type of reproducer you are utilizing the properties of your phonograph horn and reproducer, yet you may play your victrola at any time, by simply loosening the needle set screw and removing the radio speaker unit.

ALTON C. CHAMBERLIN,
Ballston Spa, New York.

A BETTER METHOD OF WINDING INDUCTANCE COILS

THE single layer solenoid coil, when supported by a minimum of dielectric, is one of the most efficient forms of inductances. One frequently sees directions for winding these coils and fastening the turns in place with strips of adhesive paper tape, such as grocers use to fasten packages. The trouble with this method is that the adhesive tape does not always hold firmly.

A coil which is much stronger mechanically may be made by using strips of paper which have been coated on one side with beeswax. From a piece of strong, good quality, paper, cut strips about half an inch wide and a little more than twice as long as the finished coil will be wide. Melt a little beeswax and, using a small brush, coat one side of each strip.

Wrap two or three turns of paper around the bottle or other cylindrical object which you intend to use as a form. Make the paper wrapping wide enough so it will project over one end of the bottle for several inches. Place the prepared strips, wax side out, at equal distances around the circumference of the bottle. Snap a couple of rubber bands over them, and everything will be held in place.

Start winding the coil about a fourth of the distance from the ends of the strips. After winding the required number of turns take the brush and paint some melted beeswax across the coil over each of the paper strips. Then run the tip of a fairly hot flatiron along the same place. The heat will melt the wax and it will run in between the turns, holding them firmly. Then bend over the ends of the paper strips and lay them along the outside of the coil, pressing them into place with the hot flatiron. They will immediately stick.

Now grasp the projecting end of the paper which was wrapped around the bottle and pull the coil and paper away from the bottle. Remove the paper from the inside of the coil, and the operation is completed.

The finished coil is strong enough for

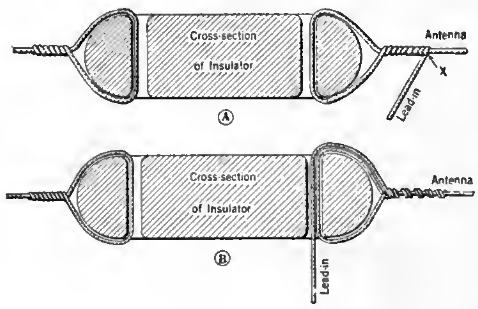


FIG. 4

any radio use. If several connections are made to it with bus bar, the bus bar will probably furnish all the support required to suspend it firmly in position in the radio set, and no hard rubber or other material need be used as a support.

H. Leslie Curtis,
Lakeport, New Hampshire.

HOW TO USE ANTENNA INSULATORS TO BEST ADVANTAGE

THE sketches in Fig. 4 show the right and wrong way of making the lead-in wire twist at the supporting insulators. In A, the wrong way, the chances are that, due to wear, the lead-in will break, necessitating repairs.

In B, the lead-in tension and friction is relieved by passing the lead-wire through the hole in the insulator.

S. P. Emerick,
Oswego, New York.

A COLLAPSIBLE ANTENNA

WITH the approach of summer readers might be interested in an idea for an antenna suitable for use in a canoe. This antenna is compact when not in use, and can be made in a short time. It is efficient too, as I have

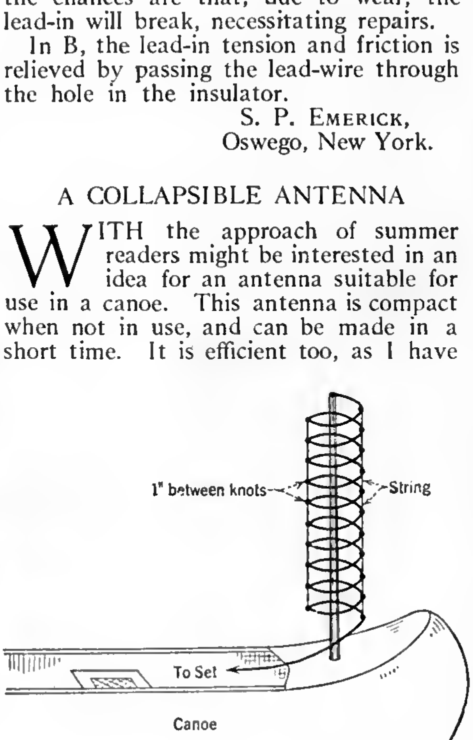


FIG. 5

received KOA on the loud speaker in Winnipeg on a home-made Browning-Drake the summer of 1925.

It consists of 50 turns of bell wire on a 4-inch tube, and, as I wound each turn on the tube, I knotted it with a string running down both sides of the coil, leaving about an inch space between knots. When the 50 turns are wound and knotted, remove the tube and an extended coil about 4 feet long will result, one end of which should be attached to the top of a sailing mast as in Fig. 5. When not in use, it can be gathered together and will not tangle.

For a ground, I used about 20 feet of 7-strand antenna wire, rolled into a hollow ball about 6 inches in diameter, and soldered wherever the turns crossed. This made an effective ground when towed through the water.

F. J. Moffatt,
Winnipeg, Manitoba.

A MARKER FOR BATTERY LEADS

MANY experimenters have occasion to use some kind of a marker for the circuits they are using in their experiments, and I have found the following method very satisfactory. Take a piece of flexible cardboard and cut into pieces about $\frac{3}{4}$ x $1\frac{3}{4}$ inches. Punch in each end a hole so that they will be about $1\frac{1}{4}$-inch apart and of such size that the wire will be free in it. Write on the card between the holes any information you wish, and thread the wire through the holes, passing the wire on the opposite side of the card from the writing. An example is shown in Fig. 6.

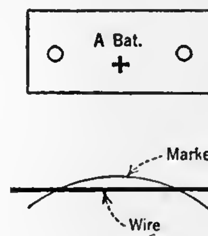


FIG. 6

V. H. Foy,
St. Louis, Missouri.

ELIMINATING OIL BURNER INTERFERENCE

THE motor on my oil burner set up a lot of interference in my superheterodyne, and as the burner seemed to want "to broadcast" every time I wanted to listen-in, I tried a good many different things to overcome it. Of course, I could shut off the burner by means of the thermostat, but that cooled off the house too much and made it uncomfortable for the rest of the household.

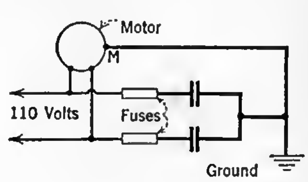


FIG. 7

Referring to the sketch, Fig. 7, it will be seen that two condensers of good sized capacity (I used 8.0 mfd.) are connected in series across the line, and the center connection grounded. The condensers must be connected across the line at the point where the interference is set up, otherwise no benefit will be derived. Another point: All wiring should be done with BX cable, and the casing grounded. The motor frames, M, and all casings around such electrical devices, must be grounded.

I found that this did away with all my interference.

James P. Baldwin,
New Britain, Connecticut.

New Services to Readers by the Radio Broadcast Laboratory

Technical Information Service to be Conducted by the Laboratory—Repair Service for Receivers—Calibration and Measurement Work

FROM this time on, all questions which were formerly sent to "The Grid" will be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

In response to many requests, lists of the various groups of apparatus tested and approved by RADIO BROADCAST Laboratory will be mailed to all inquirers without charge.

REPAIR SERVICE FOR READERS

THE service of the Laboratory will be further extended to aid readers, and we are glad to announce the inauguration of the "Repair and Service Department, RADIO BROADCAST Laboratory." The Laboratory will undertake to repair and put in condition, for a moderate charge, receivers built by readers. Only sets which have been described in this magazine will be eligible for this service. In a later number of RADIO BROADCAST, the full scope of the Repair and Service Department, will be outlined. Those readers who now have sets which they would like to submit, should communicate by letter with The Repair and Service Department of the Laboratory, RADIO BROADCAST, Garden City, New York. Facilities are available to repair readers' receivers at once. The Laboratory has no wish to compete with local radio repair services, but many readers desire to submit their sets directly to RADIO BROADCAST for attention and we are glad to accommodate those who feel that their local facilities are not sufficient to help them out of any difficulties they may have experienced.

CALIBRATION AND MEASUREMENT

A THIRD service of the Laboratory which is available to readers, is the Calibration and Measurement Service. For a moderate fee, wavemeters, coils, transformers, etc., will be measured or calibrated by the Laboratory. Characteristics of tubes will be measured and the Laboratory is in a position to perform other similar services. Communications on this subject should be addressed to the Director of the Laboratory.

Our correspondence indicates that an increasing number of readers of RADIO BROADCAST are becoming interested in home experimental radio work. Many of these newly interested experimenters have been led into this work through Keith Henney's articles which appear from time to time in the magazine, telling how the constructor can build and properly use his own simple and reliable wavemeters, audio- and radio-frequency oscillators and other important valuable laboratory apparatus. The Calibration and Measurement Service should be of practical help to these home experimenters.

REPAIR SERVICE BLANK

Repair and Service Department
RADIO BROADCAST Laboratory,
Garden City, New York.
GENTLEMEN:

I am enclosing with this blank, a letter to the Repair and Service Department, RADIO BROADCAST Laboratory. I am not forwarding my receiver at this time but I desire to submit a receiver, which is a............, described in RADIO BROADCAST for

- ☐ Repair
- ☐ Overhauling
- ☐ Rewiring
- ☐ Inspecting and Test
- ☐ ....
- ☐ ....

NAME..............................

ADDRESS..............................

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST LABORATORY,
Garden City, New York.
GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

NAME..............................

ADDRESS..............................

Why not subscribe to *Radio Broadcast?* By the year only $4.00; or two years, $6.00, saving $2.40. Send direct to Doubleday, Page & Company, Garden City, New York.

BOOK REVIEW

A Practical-Theoretical Book Especially for the Beginner

PRACTICAL RADIO. *By Moyer and Wostrel. Published by McGraw-Hill Book Company, New York, 271 pages (182 Illustrations). $1.75.*

HERE is a thorough description of the principles and practice of radio reception, written for the beginner, and avoiding too technical details whenever possible. The chief feature of the book is the large amount of practical data presented, such as the fire underwriter's regulations for radio equipment, tables of data on various tubes, instructions for reactivating thoriated filaments, a trouble shooting chart, detailed instructions for putting up an antenna, for making and using wave traps, and for making several types of radio receivers. Also directions are given for the proper care and use of batteries, a chronological tabulation of important events in the history of the art, and, in the chapter on transmission, a copy of the International Morse code with a list of conventional abbreviations, and the location of the various radio districts of the United States, is given. A good feature is the list of questions at the end of each chapter which quickly help to show the reader whether or not he has really understood what he has just read.

This is a second edition book, and in it has been incorporated much new material that brings it up to date. In several cases the new material considerably modifies the earlier conclusions. For example, the statement that audio frequency amplification is used more extensively at present than radio frequency amplification is now open to question, as the use of some form of radio frequency amplification is practically universal in commercial receivers. Likewise, soft tubes of the old type, requiring critical voltage adjustment, are no longer in general use, so that the amount of space devoted to them in the first edition is now somewhat out of proportion to their importance.

It is perhaps unfortunate that the explanation given of the action of the three electrode tube as a detector is so brief; a clear distinction between the detecting action and the repeating action of a tube is not easy to make to the beginner. Another thing that might well have been included in the list of causes of howling in audio-frequency amplifiers is acoustic feedback, which is one of the commonest causes. There are also a few technical points on which the reviewer is in disagreement with the authors. The statement that when regeneration is carried to the point of oscillation, signals will probably disappear, is not the case with ordinary tubes, though the quality of the signals will of course change. And the explanation of feedback coupling due to tube capacity, given under the heading "Tuned Plate Regeneration," seems to indicate that the grid-filament and plate-filament capacities provide a coupling between circuits. This is not so, and in other parts of the book where feedback through tube capacity is mentioned, the grid-plate capacity alone is specified, quite properly, as the coupling capacity.

The above points are of no importance to the general reader, and on the whole, the book is well written and its fund of useful information should make it a valuable addition to the radio library, not only of the beginner, but of the confirmed radio fan as well.

WALTER VAN B. ROBERTS.

A KEY TO RECENT RADIO ARTICLES

By E. G. SHAULKHAUSER

This is the eighth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the May Radio Broadcast, *and will be reprinted in an early number.*

R110. Radio Waves. Radio Waves.
Radio News. March, 1926, pp. 1285 ff.
"Speech Currents in Radiophony," J. F. Bront.
The fundamental theory underlying the transmission of radio waves ,is given. Comparison is made between effects produced by pure induction at low and high frequencies, and radiation at various frequencies. At the high frequencies, a given amount of power at the transmitter will cause a greater disturbance at the receiver than at the low frequencies, says the writer. Diagrams illustrate the discussion.

R375. Detectors and Rectifiers. Eliminators, *B-Battery.*
Radio News. March, 1926, pp. 1290 ff.
"A B Eliminator from Matched Parts," George Ames.
Construction of the Raytheon B eliminator, using Acme matched parts, is shown. Data is also given on the proper voltages for C battery, using various tubes on different plate voltages. A list of parts recommended, diagram, and photograph, give the necessary details.

R374. Detectors, Crystal. Crystals for Detectors.
Radio News. March, 1926, pp. 1300 ff.
"The Crystal Classified and Analyzed," J. F. Corrigan.
A list of minerals which may be used for the purpose of rectifying high frequency currents, and giving the chemical composition of each, is given. The crystals are classified into three groups, and each group discussed. The groups are: 1. The elementary group of crystal rectifiers; 2. The sulphide group; 3. The oxide group.

R201.5. Shielding and Grounding. Shielding.
QST. March, 1926, pp. 9–20.
"The Shielding Problem," D. R. Clemons.
Complete shielding of coils is impossible because a shield must then have zero resistance and an infinite area, states the writer. The degree of shielding depends upon the frequency, better results being obtained at higher frequencies, since current sheets are limited to a very small depth of the shield, and great thicknesses are not required.
Experiments conducted with unshielded coils showed the effect of increase in effective resistance when brought near to a condenser. The method of measuring the high frequency resistance of coils is clearly indicated and described. The resistance increase varies considerably with change in frequency. Placing the coil at least two inches from the condenser will result in practically no effect on the coil constants. Shields placed near coils, or connected directly to one end of the coil, increase the effective resistance to nearly 500 per cent., at the same time decreasing the inductance. Coils completely surrounded by shielding showed various changes in constants, depending on the size of the coil and the shielding box. Curves presented, indicate the changes. Several circuit diagrams are presented, one showing a tester for the shield material.

R460. Duplex and Multiplex Systems. Multiplex Reception
QST. March, 1926, pp. 21–23.
"Multiplex Short-Wave Reception," J. K. Clapp.
A scheme whereby several receivers may be operated simultaneously from the same antenna, is shown. With this arrangement, an operator may listen to several wave bands at the same time, making observations relative to wave band best suited to traffic under varying weather conditions, day or night. He may also be able to check wavemeters using fundamental and harmonic notes at the time that wwv sends out the standard frequency signals.

R342.5. Power Amplifier (Transmitter). Amplifier, *Power.*
QST. March, 1926, pp. 29–30.
"A Power Amplifier for the Low-Powered Transmitter," R. P. Turner.
A power amplifier to be used in conjunction with a master oscillator on high frequency telegraph transmitters, is described. It is said to be very effective in steadying the output frequency, and to add materially to better reception at the receiving end. This amplifier acts similarly to a r. f. amplifier in receivers. Circuit diagrams and constructional details are given.

R612. Short-Wave Stations. North Pole Radio Station.
QST. March, 1926, pp. 33–36.
"Amateur Radio to the North Pole Again," F. H. Schnell.
A complete description of the apparatus used on the Detroit Arctic Expedition, is given. The receiver and transmitter employ C-301-A tubes, and both sets are enclosed in aluminum boxes. The transmitter operates on two frequencies, 3750 and 7500 kc. (70 and 40 meters). The receiver covers ranges from 23,076 to 2776 kc. (13 to 108 meters). The whole outfit, including a 30-foot bamboo pole, weighs only 45.5 lbs.

R531.2. Station Call Letters. Call Letters.
Radio Broadcast. April, 1926, p. 708.
"Short-Wave Stations of the World."
A complete list of more than a hundred short-wave stations situated throughout the world is printed, including call letter, location, frequency, and wavelength.

R230. INDUCTANCE MEASUREMENT. INDUCTANCE OF FILTER CHOKE.
QST. March, 1926, pp. 39–41.
"Finding the Inductance of the Filter Choke," E. W. Berry.
A method of determining the inductance of choke coils used in filter systems after resistance and impedance have been obtained, is described. With the aid of the curve chart, the inductance is read off directly. The method of measuring the values needed, and sample calculations, clearly show the procedure used.

R110. RADIO WAVES. RADIO WAVES.
Popular Radio. March, 1926, pp. 207–212.
"A New Theory of Wave Transmission,"
E. F. W. Alexanderson.
The writer enters into a discussion on the relation between the electron, the ether, and magnetism, and proceeds to show that all the theories of radio waves heretofore propounded fail to explain certain radio phenomena. In the course of his researches into the mysteries of radio waves, the author developed a new theory which explains many of the old observations as characteristic behaviors of the horizontally polarized wave. This new theory, which accounts for fading and the erroneous results met with in direction finding, is studied with the aid of a mechanical model, as the several illustrations show.

R073. TRAINING OF OPERATORS. TRAINING OPERATORS.
Popular Radio. March, 1926, pp. 213–219.
"Radio as a Life Work," P. Boucheron.
The opportunities of the trained radio man in this new field of science and industry are outlined by the writer. Engineers are needed at high-powered transmitting stations used in transoceanic work, (1) as operators and supervisors of ship and other land stations, (2) as engineers for broadcasting stations, and (3) for purposes of developing the new science. The opportunities for the properly trained men are great in all branches of radio, says the writer.

R230. INDUCTANCE. INDUCTANCE.
Popular Radio. March, 1926, pp. 255–257.
"A Measurement Chart," R. J. Hoffman.
A chart is presented making the construction of toroidal coils a matter of simple calculations. The inductance equation is given, and a sample calculation worked out.

R240. RESISTANCE; DECREMENT; PHASE DIFFERENCE. RESISTANCE. *R. F. of Condenser.*
Phil. Mag. (London). Feb. 1926, pp. 428–432.
"Measurement of the Resistance of a Condenser at Radio Frequency," Chas. D. Callis.
An attempt is made at the absolute measurement of resistance of a variable condenser at a frequency of one million cycles per second. The method of measuring the r. f. resistance of a circuit is described. Since the high frequency resistance of a coil alone cannot be measured, as stated, a method was employed whereby two like coils were used in the circuit simultaneously, placed in such relation to each other that their combined resistance was equal to the resistance of one in the circuit. The equation evolved, and the curve obtained, are presented. Sources of slight error, and effect of different coil forms, are considered.

R113. TRANSMISSION PHENOMENA. TRANSMISSION PHENOMENA.
Phys. Review, Feb. 1926, pp. 189–215.
"The Propagation of Radio Waves Over the Earth,"
A. H. Taylor and E. O. Hulburt.
Larmor's theory of refraction due to the electrons of the Kennelly-Heaviside layer, does not explain the "skip-distances" for short waves. The range as a function of wavelength shows a minimum for about 200 meters, which suggests the introduction of a critical frequency term. If the effect of the magnetic field of the earth on the motion of the electron is taken into account, the modification of the Larmor theory necessary to fit it to the experimental facts is secured. A quantitative theory is here developed. The upper atmosphere is assumed to contain N free electrons per cc., and neglecting absorption, the dispersion is worked out for various modes of polarization of the radio waves. Then the skip distances are computed, making various assumptions as to the electron density distribution. Comparison with the experimental skip distances shows good agreement, and indicates that the radio waves which just reach the edge of the zone beyond are refracted around a curved path, reaching in the daytime a maximum height of from 97 to 149 miles. At this height, the electron density comes out close to 10^8 electrons per cc. At night, the electron density gradient is less, and the height is greater. These conclusions agree with physical conceptions from other evidence.
From the dispersion equation a value for waves of 60 to 200 meters is obtained, which indicates total reflection from the electron layers at all angles of incidence. From this result, combined with interference between various modes of polarization of the radio rays, a detailed qualitative explanation of many fading phenomena is presented.
Further conclusions obtained are that the ions in the atmosphere have little effect in comparison wth the electrons; that for longer waves, the Larmor theory is correct; that short waves are propagated long distances by refraction in the upper atmosphere and reflection at the surface of the earth, not by earth bound waves; that waves below 14 meters (21,426 kc.) cannot be efficiently used for long distance transmission.

R000. HISTORY. HISTORY.
RADIO BROADCAST. April, 1926, pp. 643–646.
"How Radio Grew Up," R. H. Marriott.
The writer traces the history of radio from the time of Loomis in 1872 to the year 1897, when Marconi interested a group of Englishmen in his radio devices. This period includes the experiments of Hughes, Dolbear, Hertz, Branly, Lodge, Tesla, Popoff and others. Following Marconi's early work in radio, the public soon became aware of the importance of this means of communication.

R386. FILTERS. WAVE TRAPS.
RADIO BROADCAST. April, 1926, pp. 686–688.
"Cutting Out the Locals," H. E. Rhodes.
A simple outline on the subject of interference elimination by means of tuned filter circuits, commonly known as wave-traps, is presented. The theory of the wave trap, just how and why it operates in eliminating or reducing interference, and data presented to explain the results obtained, are included in this article. The radio-frequency amplifier is considered an effective wave trap when properly built.

R131. ELECTRON TUBE CHARACTERISTIC CURVES; GENERAL PROPERTIES. VACUUM TUBES.
Radio Broadcast. April, 1926, pp. 658–663.
"The Tube and Its Best Uses," K. Henney.
The general theory and operation of vacuum tubes as detectors and amplifiers, is discussed. The testing and the practical operation of tubes is obtained by inserting proper resistances in the input and output circuit, as shown. The importance of static and dynamic curves is explained. The relative merits of transformer, impedance, resistance, push-pull and parallel operation of tubes, is considered. Loud speakers should be coupled to a circuit of proper impedance, either direct to the tube or through an impedance or transformer, in order to obtain true reproduction of signals. Discussion on the use of high-mu tubes, and facts concerning tube rejuvenation, are presented.

R344.4. SHORT-WAVE TRANSMITTING SETS. TRANSMITTER, *Short-Wave.*
Radio Broadcast. April, 1926, pp. 678–681.
"How a Portable B Battery Transmitter Works," RADIO BROADCAST Laboratory.
The results obtained with the short-wave transmitter used at 2 GY employing dry B battery supply and small input power, is outlined. Ordinary receiving tubes of various makes were used in the portable set, which employed the simple Hartley circuit. The details of construction, and records of transmission, are described.

R113. TRANSMISSION PHENOMENA. TELEPHONE TRANSMISSION PHENOMENA.
Proc. I. R. E. Feb. 1926, pp. 7–56.
"Transatlantic Radio Telephone Transmission," L. Espenschied, C. N. Anderson, and A. Bailey.
The paper reports upon measurements of radio transmission which have been made during the past two years in a study of the possibilities of transatlantic telephony. These measurements cover several different frequencies in the range below 60 kilocycles transmitted in both directions across the Atlantic, and represent probably the most comprehensive study yet made of any transmission path. An earlier paper described the special high power radio telephone system and the measurement methods employed in the tests, and gave certain preliminary measurement results. The relation which exists between diurnal and seasonal variations of signal field, and the exposure of the transmission path to sunlight, is shown. The conformity of the measured results to the values determined by formulas, is indicated. Interesting correlation is shown between abnormal radio transmission and magnetic storms.
The diurnal and seasonal characteristics of noise are shown to be generally similar to those of signal strength, and indicate the noise to be of tropical origin. The average frequency distribution of static is shown for various receiving stations. Signal to noise ratios are shown for both England and the United States for transmission on 50-odd kilocycles, together with the improvement afforded by a directional receiving system of the wave-antenna type.

R114. STRAYS (ATMOSPHERICS). ATMOSPHERIC DISTURBANCES.
Proc. I. R. E. Feb. 1926. pp. 133–138.
"The Present Status of Radio Atmospheric Disturbances," L. W. Austin.
The paper gives a résumé of our present knowledge concerning atmospheric disturbances. In Europe it is found that about 30 per cent. of these are due to thunderstorms, while a considerably greater percentage are associated with rain areas of some kind. In the United States, near the Atlantic Coast, disturbances in general come from the southwest, while on the coast of California they come from the permanent centers in the neighboring mountains. In the Middle West the direction is variable, depending on thunderstorms, rain areas, etc. In England, cathode-ray oscillograms have been taken of the atmospherics. The main disturbance is of audio frequency and usually aperiodic. Some of the curves show high-frequency ripples on the main waves. These may be real sources of atmospheric troubles.

R431. STRAYS (STATIC ELIMINATORS). MCCAA ANTI-STATIC DEVICE.
Radio. March 1926, pp. 11 ff.
"Refinements in the McCaa Anti-Static Devices," E. B. Patterson.
A detailed account of the operation of the McCaa static eliminator, is given. The theory of its operation, and the advantages derived from its use, are outlined. Constructional details are also presented, which the experimenter can follow in building one of these interference eliminators for his receiver. Circuit diagrams are explicit and complete.

R800 (621.314.3). TRANSFORMERS. TRANSFORMERS, *Design Data.*
Radio. March 1926, pp. 23–26.
"Design of Small Power Transformers and Filter Inductances," J. B. Dow.
Specifications, data, and formulas, for the construction of transformers and choke coils for use in B battery eliminators and amateur transmitters, are given. Typical examples accompany the equations for purpose of illustration. A full-page table gives design data for inductance coils with iron cores, from 0.05-to 0.50-ampere carrying capacity. A table giving measurements of copper wire and turns per square inch is included.

R344.4. SHORT-WAVE GENERATORS. TRANSMITTER, *Short-Wave.*
Radio. March, 1926, pp. 29 ff.
"A Baby Radio Transmitter," W. H. Hoffman.
The construction of a compact 7500-kc. (40-meter) transmitter using a UV-199 tube and dry cells for power supply is outlined. The circuit employed is the modified Colpitts. The particular circuit arrangement was developed by the Burgess Laboratories. The antenna system is adjusted to resonance by means of a flashlight lamp and battery, or a hot wire instrument. A loop may also be used for the 7500 kc. (40-meter) band, it having a single turn three feet on a side, a three-plate variable condenser and a three-inch coupling coil being in series.

R320. ANTENNAS. ANTENNAS.
Radio. March, 1926. pp. 35–36.
"Using the Right Transmitting Antenna," F. C. Jones.
Several types of short-wave transmitting antennas are discussed, and their method of operation outlined. The type of antenna to use depends upon the surroundings and local conditions, according to the writer. Photographs and diagrams of several types, are presented.

R113. Transmission Phenomena. Broadcast Transmission Phenomena.
Proc. I. R. E. Feb. 1926, pp. 57–131.
"Some Studies in Radio Broadcast Transmission," R. Bown, D. K. Martin, and R. K. Potter.
The paper is based on radio transmission tests from station 2 XB, in New York City, to two outlying field stations. It is a detailed study of fading and distortion of radio signals under night-time conditions in a particular region, which may or may not be typical. Night-time fading tests, using constant signal frequencies and bands of frequencies in which the receiving observations were recorded by oscillograph, show that fading is selective. By selective fading is meant that different frequencies do not fade together. From the regularity of the frequency relation between the frequencies which fade together, it is concluded that the selective fading is caused by wave interference. The signals appear to reach the receiving point by at least two paths of different lengths. The paths change slowly with reference to each other, so that at different times the component waves add or neutralize, going through these conditions progressively. The two major paths by which the interfering waves travel are calculated to have a difference in length of the order of 135 kilometers for the conditions of the tests. Since this difference is greater than the distance directly from the transmitter to receiver, it is assumed that one path at least must follow a circuitous route, probably reaching upward through higher atmospheric regions. Various theories to explain this are briefly reviewed. The territory about one of the receiving test stations in Connecticut, is found, under daytime conditions, to be the seat of a gigantic fixed wave interference or diffraction pattern, caused in part by the shadowing of a group of high buildings in New York City. The influence of this pattern on night time fading is discussed. It is considered a contributing but not the controlling factor. Tests using transmission from an ordinary type of broadcasting transmitter show that such transmitters have a dynamic frequency instability, or frequency modulation, combined with the amplitude modulation. At night, the wave interference effects which produce selective fading, result in distortion of the signals when frequency modulation is present. It is shown that stabilizing the transmitter frequency eliminates this distortion. A theory explaining the action is given. The distortions predicted by the theory check with the actual distortions observed.
A discussion of ordinary modulated carrier transmission, carrier suppression, and single side band transmission in relation to selective fading is given. It is shown that the use of a carrier suppression system should reduce fading.

R376.3. Loud-Speaking Reproducers. Loud Speaker Construction.
Radio. March, 1926, pp. 32.
"Construction of a Simple Cone Type Speaker," E. C. Nichols.
The constructional details of a simple and effective loud speaker of the cone type, is given. The horn is made of paper, which is mounted in a chamois supporting ring and energized through contact with the diaphragm of a regular loud speaker unit. The whole arrangement is then mounted on a wooden frame. The method of adjusting the speaker for best results, is given.

R344.3. Transmitting Sets. Transmitter, *50-Watt, 6 XAO*
Radio. March, 1926, pp. 37–39.
"The 50-watt Transmitter at 6 XAO," G. M. Best.
Constructional details of station 6 XAO's 50-watt transmitter, operating on the high frequency band of 3750 to 30,000 kc. (80–10 meters), are given. The set is built in three parts, the aerial tuning circuit panel, the transmitting panel proper, and the power unit panel. The circuit diagram and arrangement of parts, including a list of material required, are presented.

R351. Simple Oscillators. Oscillators, *Short-Wave.*
Radio. March, 1925, pp. 39 ff.
"Parallel Wire Short-Wave Oscillators," F. C. Jones.
Experimental results on frequencies below 60,000 kc. (5 meters) using vacuum tube oscillators in standard circuits, are outlined by the writer. Several types of oscillators, including amplifiers for use in connection with oscillators, are used on waves of 75 cm. length although they are said to operate on waves still shorter. For work on the 75 cm. band, a parabolic reflector is shown and described.

R113.5. Meteorological Phenomena. Weather and Radio.
Radio News. March, 1926, pp. 1256 ff.
"Radio Forecasting," E. B. Rideout.
In the writer's opinion, the two most important things that enter into the influence of weather on reception are temperature and barometric pressure variations. The creation of electrical discharges, through mixture of hot and cold air, setting up static waves, together with developments of large storm areas, account for much of our poor reception due to fading and atmospherics. Typical results, based upon actual observations, are related.

R131. Electron Tubes; General Properties. Electron Tubes.
Radio News. March, 1926, pp. 1255 ff.
"What Happens in Vacuum Tubes," Dr. A. Katsch.
Although theoretical formulas have been developed covering the actions taking place within vacuum tubes, such formulas contain many generalizations, and it is necessary to depend to a great extent upon actual research and experimental work in order to determine what goes on within the tubes, declares the writer. Photographs are shown of the discharge glow of electrons in a partial vacuum.

R800 (533.85) Vacuum Apparatus. Vacuum Pumps.
Radio News. March, 1926, pp. 1282 ff.
"How Radio Tubes Are Evacuated," Dr. C. B. Bazzoni.
Methods of producing vacua are described. Simple and effective pumps are shown which may be used by the experimenter in evacuating his own tubes. Various types of pumps are classified as follows: 1. Water or steam injector air pumps; 2. Ordinary piston air pumps; 3. Oil-sealed piston air pumps of the Geryk pattern; 4. Oil-sealed rotary air pumps of the Trimount pattern; 5. Stationary mercury air pumps, of the Sprengel pattern; 6. Rotary mercury air pumps of the Gaede pattern; 7. Mercury jet diffusion air pumps, of the Langmuir pattern; 8. Rotary cylinder molecular pumps of the Holweck pattern. The principles of operation of these types is described. Particular details of the simple Guichard type of Sprengel pump are given. The writer states that vacua of the highest degree may be obtained with these simple types of pumps.

Weather Forecast Transmissions by Radio

THE following stations in the Illinois section send out regular weather forecasts and reports by radio. With the exception of NAJ and WGO, all reports are in telephony. Amateurs who receive any of these transmissions are requested to write to the Weather Bureau Office, Springfield, Illinois, and report on the quality and service, and say how distinctly the stations are received.

NAJ, Great Lakes . . 151 kc. 1988 meters
9.45 A. M. Morning Lake Forecasts.
4.00 P. M. Storm Warnings.
10.00 P. M. Evening Lake Forecasts.

WGO, Chicago . . . 337 kc. 890 meters
11.00 A. M. Local and Lake Forecasts.
4.00 P. M. Local and Lake Forecasts.
9.00 P. M. Evening Local and Lake Forecasts.

WLS, Chicago . . . 870 kc. 344.6 meters
9.00 A. M. Morning Forecasts, Special Warnings.
12.10 P. M. Same as 9 A. M.
Corn and Wheat Region Summary Wednesday.
12.00 NOON Aviation Forecasts Except Sunday.

KYW, Chicago . . . 560 kc. 535.4 meters
12.00 NOON† Morning Forecasts.
4.15 P. M.† Special Warnings.
10.00 P. M.† Except Monday—Evening Forecasts.

WAAF, Chicago . . 1080 kc. 278 meters
10.30 A. M. Morning Forecasts. Weather-Crop Summaries on Wednesday During Crop Season.
12.30 P. M. Repeated; and Saturday gives Weekly Forecast.
Except Sunday and Important Holidays.

WHT, Chicago . . . 1260 kc. 238 meters
11.30 A. M.† Morning Forecasts. Corn and Wheat Region Summary Wednesday.
12.00 MIDN'T Evening Forecasts. Except Sunday.

WJBC, La Salle . . . 1280 kc. 234 meters
12.30 P. M. Morning Forecast. Except Sunday.

WOC, Davenport . . 620 kc. 483.6 meters
12.45 P. M. and 2.00 P. M. Except Saturday (1.00 P. M.) and Sunday. Morning Forecasts, General Weather Conditions. Weather-Crop Summaries on Wednesday.
9.00 P. M. (Soon After) Except Sunday (9.45 P. M.) and Monday. Evening Forecasts; Special Cold Wave Warnings Sent as Flashes.

WEW, St. Louis. . . 1210 kc. 248 meters
10.00 A. M. Morning Forecasts, General Weather Conditions.
5.00 P. M. Special Warnings. Except Sunday.

KSD, St. Louis . . . 550 kc. 545.1 meters
10.40 A. M. Morning Forecasts, General Weather Conditions, River Stages.
12.40 P. M. Special Warnings
1.40 P. M. Repeated.
3.00 P. M. Repeated.
10.00 P. M. Evening Forecasts. Except Sunday.

KMOX, St. Louis . . 1070 kc. 280.2 meters
10.00 P. M. Evening Forecasts. Except Sunday.

†One hour earlier during Chicago "Daylight Saving."

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A Neglected Angle of the Radiation Question

By HAROLD JOLLIFFE

A RADIO receiver which is allowed to go into a state of oscillation while a station is being tuned-in, is the cause of the most potent and destructive of all forms of interference experienced on the broadcast band of frequencies.

One can, as a rule, get away from the pernicious roll and crackle of a severe static storm by tuning-in the powerful signals of the local stations; and if any interference created by two stations heterodyning each other is manifest, one may always seek another station which comes in at a point on the dial where this interference is not present.

But there is positively no surcease from the demoralizing shrieks and squeals of an improperly operated regenerative or oscillating radio frequency set. The attention-compelling warning of the fire engine is as soft music compared to the shrill, siren-like whistles and groan-like crescendos frequently issuing from the loud speaker. And, somehow or other, these destructive agents always seem to have the knack of arriving on the scene just at the critical moment when the zealous soprano has reached high C, or when the violinist is applying his best efforts to the last few notes of his number.

Many interesting articles have appeared from time to time in the various journals devoted to radio, showing how unnecessary interference created by an oscillating receiver may be avoided by the proper handling of the controls when a station is being tuned-in; and there is no doubt that if these instructions were carefully followed by all, the ether would not be the bedlam that it sometimes is. Other writers of constructional articles have gone a step further by pointing out the desirability of so building a set that a transfer of energy from the oscillating circuit to the antenna is prevented. As an example of this, we have the well-known Teledyne and Browning-Drake receivers, both these sets being equipped with a single stage of non-oscillating radio-frequency amplification. This allows the detector to be set into oscillation whenever desired, but at the same time isolates these oscillations in the detector circuit so that they cannot be radiated from the antenna. Hence, both these receivers, and others designed along similar lines, are generally referred to as non-radiating, which they are according to the present definition of the word.

Then there is a comparatively recent development, a "capacity-bridge" arrangement, designed as a unit by itself, the purpose of which is also to eliminate radiation from the antenna when it is connected between the antenna and the oscillating receiver. This method of preventing unnecessary interference is somewhat different from the one mentioned in the foregoing paragraph and probably more efficient. But the main point to remember is that both prevent radiation from the *antenna*. Note that I have stressed the word "antenna." The reason for this will become apparent in just a moment.

Now, it is obvious that the theory involved in both the above blocking arrangements is that so long as oscillations are prohibited from reaching the antenna but are confined to the receiver itself, radiation is entirely eliminated, and therefore no interference is caused to listeners in the neighborhood. From this, taking it at its face value, it would seem that the antenna—with the ground connection, of course—constitutes the only agency by which these oscillations may be radiated.

But is this true? Can any receiver of the oscillating type be rightfully considered non-radiating even though it be provided with a blocking arrangement? Granting that we do eliminate radiation from the antenna, does the matter end there? Is the antenna system the sole medium through which a receiver may radiate?

No, it is not!

And here I wish to step out of the beaten track long enough to state that the *coils* of any type of oscillating receiver must be reckoned with!

This has long been known in theory and, if the space this phase of the radiation situation has been granted in the magazines may be taken as a criterion, then it would appear that this fact has been known in theory only. I do not recall a single article wherein the writer made any mention of it. No one, apparently, seems to have thought it worthy of even passing consideration.

RADIATION FROM COILS IS POSSIBLE

TESTS made by the writer indicate quite conclusively that an oscillating receiver does not depend wholly upon the antenna system for radiation, but that the coils in the oscillating circuits can and do radiate, and that this radiated energy may carry for some distance, and certainly create interference within a reasonable area, the extent of which can only be vaguely guessed at.

This is quite logical; in the very nature of things it couldn't be otherwise. And those who are willing to grant the theory but at the same time claim that the energy radiated by a small coil, or coils, would be so infinitely little as to be incapable of causing any appreciable interference, will have to give the subject more serious consideration.

We have only to remember the tremendous distances being covered by members of the amateur transmitting fraternity to realize completely just what a vacuum tube is capable of. Only recently were we informed of the accomplishments of an amateur in British Columbia. This gentleman, using an ordinary receiving tube and less than three-hundred volts of B battery for the plate voltage, actually succeeded in establishing communication with a brother amateur in Australia!

Then again, one constantly hears of amateurs who, with receiving tubes and only ninety volts on the plate, get a range of from ten to twenty miles, with good, strong signals at the receiving end. And bear in mind that this is with ordinary receiving tubes.

Consider, then, is it not logical to suppose that a small coil, perhaps four inches in diameter and wound with a large size wire, connected in the grid circuit of an oscillating tube, or three such coils (as in a two-stage tuned radio-frequency amplifier), will also send out a certain amount of energy? Why not? They are, in effect, miniature loop antennas, and it is a well-known fact that it is possible to transmit over short distances with a loop. A small coil, such as is generally used in present-day receivers, would send out a very weak wave, and although on the lowly crystal set it would probably make no impression, with most sets of to-day capable of extremely high amplification, the matter takes on a greater significance. The fact that it is not solely the power used at a transmitting station which determines the range of that transmitter but also the degree of radio frequency amplification at the receiving end, has been amply demonstrated in other branches of radio transmission.

RESULTS OF ACTUAL EXPERIMENTS

WHEN broadcasting commenced on a large scale a few years ago, and it was found that oscillating receivers became miniature transmitters under certain conditions, and so caused interference to neighboring receiving sets, no one thought that these radiations could possibly carry for any great distance. The writer recalls an article published over three years ago wherein its author stated that "such a receiver may cause interference to other listeners-in within an area of several blocks."

To-day, it is a generally understood fact that this range is perhaps several miles; no one knows exactly. But we do know that it varies in direct proportion to the efficiency of the radiating receiver and the sensibility of the receiver picking up these radiations.

And so, when a sensitive receiver, such as a super-heterodyne, a neutrodyne, or a Roberts is being employed at the receiving end, the matter of radiation direct from the coils of another set in the neighborhood assumes a serious aspect. And as the art progresses and receiving sets are continually improved upon and made more and more efficient, likewise this side of the radiation nuisance will become more acute.

Reference was made above to some tests made pertaining to this class of radiation. Briefly, they were as follows.

Using an oscillating two-stage tuned radio frequency set with only forty-five volts on the plates of all tubes, and employing neitner an antenna nor a ground—the equivalent of the most efficient blocking device—the writer caused so much interference to a friend with a five-tube neutrodyne set located approximately one hundred feet away, that it was an absolute impossibility for him to enjoy a concert from a station twenty miles distant. This was also done with a four-tube Teledyne set, the only difference being that the shrieks and howls were not so loud. This, of course, was due to the fact that the detector alone was responsible for the interference since the radio frequency tube was not oscillating, whereas with the tuned radio frequency set, all three tubes were oscillating.

Pooh! you say, that's only one hundred feet. True enough. But the radiations, especially those from the r. f. set, were received by the neutrodyne with such intensity that it is safe to say that they carried for several blocks at the least. It is quite possible that they carried all over the city.

It is, therefore, not a very difficult thing to realize just what this would mean in a very congested district where every other house boasts an antenna and where there are several receivers in one apartment building. Even assuming that none of the receivers could radiate directly from their antennas, those which could be made to oscillate would still create sufficient interference to make the air unhealthy for, no one knows just how far.

The whole thing boils down to the fact that the oscillating receiver is the bugaboo of good reception. And as long as we have these receivers, or no means of positively preventing all forms of radiation from them, radio broadcasting is not going to attain its highest pinnacle of development. And while it would be difficult to advocate the abolition of the regenerative receiver altogether, at the same time it is to be sincerely hoped that a few of our great scientists will turn their attention to this subject with perhaps worth while results.

(*It is apparent from Mr. Jolliffe's remarks that many of the receivers which are sold with an almost iron-clad guarantee to the effect that they will not radiate, are capable of doing so by means of their coils. On the strength of such guarantees as the above, many owners of receivers permit their sets to squeal during the process of tuning-in, blissfully ignorant of the fact that they can be seriously annoying their neighbors. It is hoped that this article has made clear to these listeners that even the so-called "non-radiating" receiver will cause interference if not handled with meticulous care.*—The Editor.)

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., required by the Act of Congress of August 24, 1912, of RADIO BROADCAST, published monthly at Garden City, New York for April 1, 1926. State of New York, County of Nassau.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John J. Hessian, who, having been duly sworn according to law, deposes and says that he is the Assistant Treasurer of Doubleday, Page & Company, owners of Radio Broadcast and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is...... (This information is required from daily publications only.)

(*Signed*) DOUBLEDAY, PAGE & COMPANY
By John J. Hessian, *Asst. Treasurer.*

Sworn to and subscribed before me this 1st day of April, 1926.

[SEAL] (*Signed*) William W. Thornton
(My commission expires March 30, 1927.)

WHAT OUR READERS WRITE

Broadcasting in Australia

IN THE December issue of RADIO BROADCAST appeared a list of Australian broadcasting stations as forwarded to this magazine by Mr. A. W. Watt, editor of Australian *Wireless Weekly*. Apparently there have been some slight alterations in the list since its publication, as the following letter will make clear. It is from Mr. J. Malone, chief manager of the Wireless Branch of the Postmaster-General's Department of the Commonwealth of Australia. It reads as follows:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I notice in your December issue a reference to our Broadcasting Stations' wavelengths which contain some incorrect particulars. The wavelengths and powers of the stations listed on page 224 should read as follows:—

CALL SIGNAL	WAVELENGTH IN METERS	POWER IN WATTS
2 FC	1100	5000
2 BL	353	1500 (shortly to be increased to 5000)
3 LO	371	5000
3 AR	384	1500
5 CL	395	5000
6 WF	1250	5000
7 ZL	417	3000
4 QG	385	5000

We are at present considering the reallocation of the wavelengths, and there are likely to be some slight modifications to permit of a wider frequency band being employed.

Trusting you do not mind my correcting these slight inaccuracies.

Very truly yours.
J. MALONE,
Chief Manager, Telegraphs and Wireless
Melbourne, Australia.

From an Old-Timer

HERE is a letter from an old-timer in the "wireless" game who was attracted by Mr. Baskerville's article of his experiences which appeared in the May RADIO BROADCAST.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I was carried back to old times by Mr. Baskerville's article in the current RADIO BROADCAST. It recalled the days in the service of the old United Wireless, at 42 Broadway, when I worked with Baskerville, Murphy, Hughes, and Gregg, for several years. I wonder where John Murphy is to-day?

It was a great life in those days, equipping a ship one day, the roof of the Waldorf Astoria the next, and then off to Key West to install a station. I well recall being given the job of equipping the *Olivette* and *Mascotte* when down at Key West. These had been Sampson's dispatch boats during the Spanish-American war, were very fast, top heavy, and great rollers. It fell to my lot to equip these vessels while on the trip between Key West and Havana, and it was the hardest job I ever tackled. The rolling of the ships necessitated frequent trips from the wireless room to the rail, while the dining room had little attraction.

One morning, upon my arrival at 42 Broadway, I was informed by Mr. Murphy that it was up to me to leave for Porto Rico on a steamer leaving New York in three hours, to install a station there, and to procure from the Insular government permission and land to build it on. I left the office and, with a small handgrip as my only baggage, caught the boat as she was casting off her lines. I never built the station at Porto Rico, however, for shortly after, the old "United" became a thing of the past. That little incident helps to show what kind of a life we fellows led though.

Yes, it certainly was a great life, coming into intimate contact with governors, generals, admirals, haughty captains, plain spiggotys, dock-rats, and above all, being a member of that bunch of good fellows—the old United Wireless.

And now, as I write, WJZ is booming in. What a contrast to the old days when a readable spark from a 10-kilowatt transformer, sending from Key West to Havana, was hailed with satisfaction and which the operator generally received over an illicit electrolytic detector which Hughes knew nothing about.

Very truly yours,
A. A. Weiss,
Copperhill, Tennessee.

Our Laboratory Articles

Quite a few letters come into the office following publication of Keith Henney's articles in this magazine, expressing, as a rule, unqualified appreciation, and often offering suggestions for future subjects. Here are two typical ones. The first is from the ex-operator of CNRO, while the second is from a prominent tube manufacturer.

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York.

Sir:

Just a line to say that the last issue of "our magazine" is a knockout. The expression "The Leading Radio Magazine" hardly covers it. I would very much like to see more of Keith Henney's work, such as that which appeared in the December Radio Broadcast. This is the finest way of holding interest in the radio game. I would like to see a department for the experimenter, covering coil resistance, capacity bridges, etc. Keep up the good work.

Very truly yours,
H. A. Harries (9 BG)
Westmount, Province of Quebec.

Perryman Electric Company
North Bergen, New Jersey

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York.

Sir:

I take this opportunity of complimenting you on Mr. Henney's article appearing in the February Radio Broadcast under the heading "How to Judge and Use Vacuum Tubes." Never before have I read an article that was so concise, precise, and simple in its technical detail. The ordinary layman can grasp its meaning and fully realize the importance stressed on the proper use of radio tubes.

Very truly yours,
George H. Perryman.

A remarkable improvement in audio amplification

New unit perfected by All-American Engineers gives you the full, pure, natural tone you have always sought

YOU have always wanted the ideal result in audio amplification—pure, natural tone with good volume. The laboratories of All-American Radio Corporation have developed a new method of audio amplification and now bring to you this long sought ideal result in the—

Rauland-Lyric-Trio

You know the Rauland-Lyric transformer. Its exceptional tone perfection has made it the largest selling quality transformer in the world. The Rauland-Lyric is now used in combination with the new Rauland-Trio (impedance units) to produce the Rauland-Lyric-Trio amplifier—the highest known perfection in three stage audio amplification.

It is well known that any system of amplification using instruments of similar characteristics has inherent disadvantages. Rauland-Lyric-Trio successfully combines the two leading systems—transformer and impedance coupling—coordinated to retain tne advantages of both and to eliminate their weaknesses.

This new method consists of a Rauland-Lyric transformer for the first stage, a Rauland-Trio Type R-300 impedance for the second stage, and a Rauland-Trio Type R-310 impedance for the third stage.

Rauland-Trio

This is a triple feature instrument containing an inductance, a capacity and a resistance in one compact impedance unit. Through laboratory tests of utmost precision, absolutely correct balance is maintained between these important factors. You secure full advantage of impedance amplification and overcome the common variance of commercial types of condensers and resistances. Rauland-Lyric-Trio is the last word in audio amplification.

ALL-AMERICAN TRADE-MARK

A free book, "Modern Audio Amplification," tells more about this interesting new development. Write for handbook B-90.

ALL-AMERICAN RADIO CORPORATION
4211 BELMONT AVE., CHICAGO, U. S. A.

Station WENR—*266 Meters—is owned and operated by the All-American Radio Corporation*

RADIO BROADCAST

Willis K. Wing, Editor

JULY, 1926

Keith Henney, Director of the Laboratory

John B. Brennan, Technical Editor

Vol. IX, No. 3

CONTENTS

BEHIND EDITORIAL SCENES

FOR those who have been wondering, "Whither is radio design going?" several of the articles in this issue should prove especially interesting. Mr. Zeh Bouck's leading article, for example, shows how the newest products of the manufacturers—which were announced in time to be included in his story—are meeting the new trends in radio design. Professor Morecroft in his always interesting "March of Radio" sketches some of the important engineering problems which are to be met. And in the paper by Mr. Aceves, one finds an extremely good outline of the technical trend of radio receiver design in recent months. So the July issue is really a forecast number—what to expect in receiver design.

ZEH BOUCK, author of the leading article, is well known to old readers of RADIO BROADCAST. For a long time he conducted the department, "In the R. B. Lab." He is now preparing a series of constructional articles which are more than interesting. We shall have something to say about that in a later number. Keith Henney's article on "Wavemeters for the Home Laboratory," besides showing the many valuable uses of simple wavemeters, tells something about the use of quartz crystal oscillators. So many experimenters are interested in the uses of quartz and the information is timely.

ARTHUR LYNCH'S article describing the construction of a high quality amplifier and power supply will interest those who seek good quality and a way to make their 110-volt a. c. work for them. . . . How many thousands of our readers have built the Hammarlund-Roberts, we do not know, but it is certain that the article on page 228, sketching important, and for the most part, extremely simple improvements in that set, will interest them extremely.

Also, there is the interesting story by Mr. Dashiell on where summer static comes from, and a companion story by Mr. Bishop, describing the installation and use of the lightning arrester. Lightning and static are not to be feared, once we know both ogres for what they are.

ANOTHER Radio Club paper will appear in the August RADIO BROADCAST, one by A. F. Van Dyck, an engineer of the Radio Corporation. The story deals with modern radio and the electrical phonograph. We shall soon publish a story about A batteries. They are not always what they seem, and we learn from this article what to buy and how to avoid being deceived. A host of interesting material for the set constructor, the general technician, and the casually interested radio person will be found in the August RADIO BROADCAST.

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Patent Information

furnished by Radio Corporation of America

Many inquiries are made in respect to the patent situation on vacuum tubes, such as are used for radio purposes. The Radio Corporation of America takes this method of answering these inquiries and states that there are numerous patents under which its tubes are manufactured and sold. Among these patents, not excluding others, are the following:

921,526, May 11, 1909, Eisenstein
954,619, Apr. 12, 1910, Fleming
982,873, Jan. 31, 1911, Regenstreif
1,022,182, Apr. 2, 1912, Dempster
1,032,476, July 16, 1912, Fagan
1,066,468, July 8, 1913, Chubb
1,082,933, Dec. 30, 1913, Coolidge
1,105,050, July 28, 1914, Whitney
1,113,745, Oct. 13, 1914, Blow
1,116,595, Nov. 10, 1914, Knight
1,124,555, Jan. 12, 1915, Thatcher
1,140,134, May 18, 1915, Eldred
1,140,136, May 18, 1915, Eldred
1,154,081, Sept. 21, 1915, Weintraub
1,180,264, Apr. 18, 1916, Lederer
1,191,630, July 18, 1916, Weintraub
1,196,744, Aug. 29, 1916, Chubb
1,203,495, Oct. 31, 1916, Coolidge
1,204,456, Nov. 14, 1916, Knight
1,209,324, Dec. 19, 1916, Nicolson
1,231,764, July 3, 1917, Lowenstein
1,244,216, Oct. 23, 1917, Langmuir
1,244,217, Oct. 23, 1917, Langmuir
1,268,647, June 4, 1918, Van Keuren
1,266,394, Dec. 3, 1918, Northrup
1,287,265, Dec. 10, 1918, Dushman
Re-14,572, Dec. 17, 1918, Nicolson
1,293,781, Feb. 11, 1919, Hoyt
1,294,694, Feb. 18, 1919, Nolte
1,303,579, May 13, 1919, Nicolson
1,307,510, June 24, 1919, Nicolson
1,316,967, Sept. 23, 1919, Moore
1,329,283, Jan. 27, 1920, Arnold
1,341,006, May 25, 1920, Babcock
1,353,976, Sept. 28, 1920, Stoekle
1,354,939, Oct. 5, 1920, Arnold
1,374,679, Apr. 12, 1921, Pratt
1,398,665, Nov. 29, 1921, Arnold
Re-15,278, Jan. 31, 1922, Langmuir
1,409,658, Mar. 14, 1922, Brann
1,423,956, July 25, 1922, Mitchell & White
1,423,957, July 25, 1922, Mitchell & White
1,444,438, Feb. 6, 1923, White
1,456,505, May 29, 1923, Knoop
1,456,528, May 29, 1923, Arnold
1,461,360, July 10, 1923, Lederer
1,464,104, Aug. 7, 1923, Nicolson
1,472,477, Oct. 30, 1923, King
1,477,868, Dec. 18, 1923, Donle
1,477,869, Dec. 18, 1923, Donle
1,478,072, Dec. 18, 1923, Van der Bijl
1,479,778, Jan. 1, 1924, Van der Bijl
1,480,219, Jan. 8, 1924, Nicolson
1,498,908, June 24, 1924, Fink
1,506,468, Aug. 26, 1924, White
1,529,597, Mar. 10, 1925, Langmuir
1,531,966, Mar. 31, 1925, Mackay
1,536,855, May 5, 1925, Houskeeper
1,558,436, Oct. 20, 1925, Langmuir
1,558,437, Oct. 20, 1925, Langmuir
1,565,857, Dec. 15, 1925, Kelly

To enforce the rights secured by these patents, suits have been brought and are now pending on the following patents included in the above list:

1,558,436, Langmuir
1,082,933, Coolidge
1,231,764, Lowenstein
1,244,216, Langmuir
1,244,217, Langmuir
1,529,597, Langmuir
1,341,006, Babcock
1,423,956, Mitchell & White
1,423,957, Mitchell & White
Re-15,278, Langmuir

Suits on other patents in the above list are in preparation and such further steps as may in the future be deemed necessary will be taken to fully enforce the rights which these patents grant.

Radio Corporation of America

RECEIVING TRANSATLANTIC PHOTOGRAPHS IN LONDON

Captain R. H. Ranger, of New York, who developed the "photoradiogram" transmitter for the Radio Corporation of America. The apparatus shown is the receiver. During the recent British general strike, its progress was shown by snapshots made in London, radioed to New York, and printed in newspapers, in some cases not more than twelve hours after they were taken

RADIO BROADCAST

VOLUME IX | NUMBER 3

JULY, 1926

Looking Ahead to 1927

How the New Tubes Will Affect Design and Be the Cause of Improved Quality—The Advent of the High-Voltage Line-Supply Unit—Better Loud Speakers and Audio Stage Resistance Units

By ZEH BOUCK

EVER since those far-off days when fanfares of trumpets celebrated the sending of the letter "S" across the Atlantic Ocean, the attention of the radio engineer and designer has been devoted to increasing the sensitivity of his apparatus, and his problem has been to receive more distant signals. It has only been during the most recent years of the broadcasting era, however, that more than just passing attention has been devoted to improving the quality of reproduction of the average receiver.

Several factors have combined to bring about this alienation from an old ideal. First of all, there is the realization that increasing the sensitivity of a receiver beyond definite limits has the effect of raising the noise level (bringing in those parasitic strays of static, door-bell radiations, and the like), with a volume that is uncomfortably out of proportion to the true ratio of stray energy to average signal strength.

Super-power transmission has also served to subdue that perpetual inquiry into the nature of greater sensitivity by demonstrating a logical method of providing adequate signal strength on distant stations with an effective reduction of the noise level. The idea is a very simple one, and consists merely of putting more power into a signal than chance puts into strays. Another important factor in this mild revolution in radio development is the very much improved quality of local programs, with the consequent lessened excuse for distance angling.

RADIO BROADCAST took the initial step toward quality reproduction in presenting the first resistance-coupled audio amplifier to the public, in May, 1924.

Since that time, the emphasis has been placed more and more on quality while less attention has been paid to other considerations. The most recent appreciation of this new point of view is reflected in the power tubes brought out by the Radio Corporation, Cunningham, and other organizations.

Like super-power, the power tube was a logical development in radio progress. It is impossible, regardless of the excellence of one's amplifier, loud speaker, and associated apparatus, to obtain quality if the tubes distort. All tubes, under certain battery and load conditions, can output just so much audio frequency power without the strains, twists, and stresses we know as distortion. In the case of the average listener, the signal intensity demanded from his amplifier is in excess of the distortionless capacity of the 201-A type of tube.

Fundamentally, there is one way of increasing the audio frequency power variations a tube can handle without distortion, and that is by the simple expedient of raising the plate voltage with corresponding C battery changes.

THIS IS THE HYPERION MODEL ELECTROLA–VICTROLA

Which is operated directly from the a.c. supply mains. The reproduction from the records is through electrical pick-up, electrical amplification, and the cone, which is also utilized for the radio side of the instrument. An UX-120 power stage gives undistorted output with volume. The instrument retails at $900

In addition to "straightening out the characteristic curve of the tube,"—which is another way of saying that the power-handling ability of the tube has been increased, raising the plate voltage tends to improve the impedance relationship between the tube and its "load," the loud speaker. Thus, bringing up the plate voltage of an audio amplifying tube is in the nature of a cure-all for distorting ills.

However, it becomes necessary to design tubes capable of withstanding the strains imposed by these high plate voltages, and at the same time it is desirable to incorporate other modifications which, often reducing the voltage amplification, increase the ability of the tube to handle power.

Quite logically, the power handled in an amplifier increases progressively from the minute variations in the detector plate circuit to the relatively violent fluctuations in the windings of the loud speaker. It is only in the last stage of the average amplifier that these fluctuations exceed the distortionless capacity of small tubes. Therefore, power tubes are rarely necessary in any amplifying step other than the output or final stage.

THE UX-210 AND THE CX-310

THE reader is probably familiar with the smaller power tubes such as the UX-112, 120 (CX-212 and 220), which are overgrown 201-A and 199 types respectively, as well as the somewhat similar tubes manufactured by Daven, Schickerling, and other companies. These tubes, which are to be continued through the coming season, have advantages over the 201-A and 199 types, and are designed for operation from plate voltages under 150, and A potentials no higher than six volts. They are, however, inadequate in the majority of cases.

The first of the relatively high-power tubes, the influence of which is reflected in the design of associated apparatus, is the UX-210, and the corresponding Cunningham CX-310 tube. This new tube is designed for operation from a 300-volt plate supply. At 7 volts, its XL filament draws 1.1 ampere. The UX-210 lists at $9.00.

Operated according to directions, this new tube, in a power stage of amplification (following two steps of transformer, impedance, or resistance coupling). will feed enough undistorted power into a really good loud speaker to fill a medium size

Radio Broadcast Photograph

AMSCO'S NEW RESISTOR-COUPLER UNIT
Which is of special rugged construction. The necessary coupling condenser is sealed in the base of the coupler. Price $2.45 with resistors

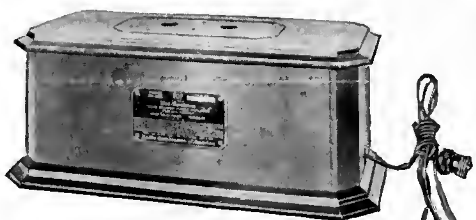
hall with orchestra volume. Plate potentials as high as 450 volts can be applied to the UX-210 with increased undistorted volume.

As already suggested, tube innovations must affect receiver design fundamentally, and will be reflected in changes in the associated apparatus. And thus it is that the 1926-1927 season will provide a market for new and interesting equipment.

First of all, it is obviously impractical to supply 300 volts (or more) to the plate of a CX-310 type tube from a B battery. If lower voltages, within the economical limits of B battery operation, are applied, little will be gained by the use of the large tube.

Similarly in respect to the 7-volt filament potential; while the tube will light and operate with only 6 volts across the terminals, its distortionless amplifying possibilities are impaired.

A STROMBERG-CARLSON CONE
The use of a soundboard on this speaker is said to add timbre and volume



THE UNI-RECTRON
Is an amplifier capable of delivering considerable volume when connected to the output terminals of a receiver which already employs one stage of amplification. The Radio Corporation retails this instrument at $105, and it obtains both filament and plate power from the a.c. line

The line power-supply unit, several of which are now on the market, is the obvious answer to the problem.

The AmerTran line power unit is typical of the desired arrangement. The 110-volt lighting current is stepped up to the requisite high voltage and rectified by means of 216-B rectifying tubes. A three-step amplifier is incorporated in the unit, consisting of two 201-A stages outputting to a UX-210. This line power unit, with tubes, retails for $125.00.

The Pacent line power device is similar to the AmerTran excepting that it includes only the power stage of amplification, and sells for $82.00 without tubes.

Voltage taps provide plate potentials for other sections of the receiver.

Another popular power amplifier with self-contained line power apparatus, is the R. C. A. Uni-Rectron, selling for $105.00. The R. C. A. and the Pacent units are designed for operation from the first or second stage of the conventional amplifier.

Special secondary windings supply the required 7-volt filament potential in the Uni-Rectron line power units. The tubes in the receiver, however, must be lighted from an A battery. Grid bias potentials are secured by an IR drop within the rectifying unit, thus eliminating the C battery. It might be well to note here (particularly for the benefit of the home constructor) that power tubes, as a general rule, require comparatively high C voltages, running from $22\frac{1}{2}$ to as high as 75 volts, depending on the type tube and the voltage applied to the anode.

A corresponding design by the Western

THE 36-INCH W. E. CONE
The use of tubes capable of delivering more power without distortion necessitates the use of speakers capable of delivering such volume faithfully. It is said that the power handling capabilities of the cone may be increased by adding to the diameter. The new Western Electric cone is three feet across

Electric Company is observed in their 205 amplifier line power unit (list $115.00 with tubes). This amplifier employs two 25-D tubes, one rectifying and one amplifying.

The UX-210 or CX-310 power tube is particularly well adapted to the requirements of electric phonograph reproduction, and is found in many of the recent Victor and Brunswick designs.

The Cromwell Victrola ($450.00) employs such an amplifier, which can be used as an external power amplifier for radio receivers. Adequate power is again supplied by the transformer and rectifier combinations.

The more elaborate phonographs, such as the Radiola Victrolas from $900.00 up, combine receiving sets with power amplifiers and line power arrangements.

The Radiola No. 30, with the Rice-Kellogg speaker, is a complete receiver, plus power amplifier, operated altogether from an efficient line supply system. No batteries whatever are used.

Radio Broadcast Photograph

GREATER VOLTAGE OUTPUT FOR THE NEW TUBES

Is possible with the new Mayolian line supply unit. A Raytheon filamentless tube is the nucleus of this device, which is capable of delivering a higher potential at the desired amperage for the plates of the receiver tubes than has heretofore generally been the case with the average commercial line power supply

THE NEW UX-171

WHILE there is a definite need for a tube of the UX-210 type, the average fan will never have occasion, justified by more than neighborly spite and malice, to push these tubes anywhere near their capacity output. In appreciation of this fact, a lower power tube has been designed more consistent in price and power rating with the requirements of the fan. This tube is known as the UX-171. Cunningham manufactures it as the CX-271, while other companies, such as the Cleartron and the Ureco, making similar tubes, refer to it merely as their trademarked 171 tube. The Radio Corporation and Cunningham tubes of this type list at $6.00, while those of other manufacturers mostly sell at one dollar less.

This medium power tube, which, properly operated, should prove the ideal output tube for the fan, is designed for operation from the conventional six-volt filament source, drawing one half ampere, and from a plate supply of 180 volts. As will be noted in laboratory sheet No. 12 in this issue of RADIO BROADCAST, at 90 and 135 volts the proper biases are 16.5 and 27 volts respectively, and under these conditions sufficent undistorted power output will be delivered for all ordinary purposes. The plate currents will be approximately 13.4 and 16.5 milliamperes; this means that at 90 and 135 volts the 171 is an economic B battery tube. Operated on plate potentials under 180 volts, the medium power tube is still superior to lower power tubes.

The design of line power units will no doubt be modified to meet the requirements of the new tube. Several manufacturers, in anticipation of the 171's popularity, have discontinued their relatively low-voltage line power arrangements in favor of systems supplying 180 volts. Apco is bringing out an 180-volt line supply in several models, including baseboard and inclosed arrangements, employing the UX-213, and Raytheon rectifying tubes. The price on this apparatus will vary from $38.00 to $45.00 with rectifying tubes. A similar device is the Mayolian, a cabinet job, selling for $55.00.

As may be noted, the rectifiers used in representative line supply units are the Raytheon, an efficient no-filament tube; the UX-213 (CX-313), a full wave electronic tube; and the UX-216-B (CX-316-B), a half wave electronic tube.

A new electrolytic rectifying bulb is being brought out by the Forest Electric Company for use in their line supply products.

The 171 tubes can be operated from low-voltage line power units at high efficiency, by the simple expedient of connecting a heavy duty B battery in series with the loud speaker (plus post to plate of the power tube). This increases the plate voltage applied to the last tube.

The Apco Electric set anticipates the demand for receivers designed for use with the 171 type tubes. All batteries are eliminated in this set, and a plate potential of 180 volts is applied to the output tube. This receiver will be priced under $200.00.

To justify fully the use of the power tube, the loud speaker must be constructed to handle its output, again reflecting the influence of tube design on associated apparatus. The power handling capabilities of loud speakers can be increased by extending the air column, in the case of the horn type, and by increasing the diameter of the cone in the cone type.

These principles are typified respectively in the researches of the Miller Rubber Company, who are manufacturing horns with four to six foot air columns, and the Western Electric Company, who are producing a 36-inch cone selling for $76.00.

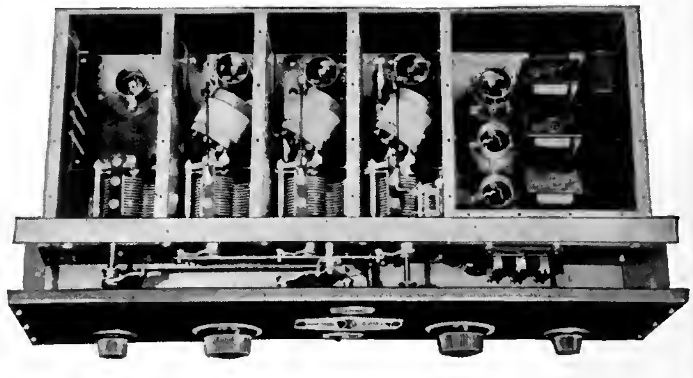
Another cone power speaker of rather different design is incorporated in the R. C. A. Rice-Kellogg unit. The A and B powers, and C potentials, are supplied to the UX-210 power tube, and the receiver tubes, through a system of 216-B rectifying tubes, a ballast tube, and a voltage regulator.

THE EIGHT-TUBE "RADIOLA 30" SUPER-HETERODYNE

This instrument retails for a little under $600 complete and ready to operate. It is capable of exceptionally great volume when required, and obtains all power direct from the a.c. house supply

THE PACENT POWERFORMER

This unit is somewhat similar in nature to the Radio Corporation's Uni-Rectron. Voltage taps on the instrument provide for the plate potential requirements of the tubes other than those in the Powerformer. $82 without tubes



THE HOWARD SEVEN-TUBE NEUTRODYNE

Embodies all the patented Hazeltine features and is a totally shielded receiver. In this illustration, the top shield has been removed to show the disposition of the parts. Three r.f. stages are employed, as are also three stages of specially designed audio amplification. A loop is used, and the Howard is adapted for use with light socket power devices

Refinements—a general movement toward increased quality—evidenced in improved actuating mechanisms and horn material, are to be noted in the Teletone and Amplion speakers.

Still further exhibiting the influence of the power tube, the fact that it is undesirable to place the loud speaker directly in a high-voltage high-current plate circuit has suggested to manufacturers the convenience of an output coupling unit. This consists of a high-impedance choke coil shunting the a. c. power variations through a bypass condenser to the loud speaker. Among several desirable effects, such an arrangement eliminates the relatively powerful magnetic influence of the direct plate current tending to draw the diaphragm toward one of the pole pieces, which results in rattling when loud signals are being received. Such a unit is on the Amsco list of fall production.

In passing, it may be well to mention several new tubes less directly associated with quality amplification. Two super sensitive detector tubes, the R. C. A. 200-A and the Donle-Bristol, have made their appearance. While it is not intended that these tubes should replace 201-A types in the detector socket of receivers, they will probably be quite popular on account of their extreme sensitivity. Reception with the R. C. A. 200-A is accompanied by a slight hiss caused by the action of the gaseous content within the tube. The Cleartron r. f. tube, featuring a relatively high amplification constant, has been developed especially for radio frequency amplification circuits, where the manufacturer claims for it a distinct superiority over other tubes, in this position. The three above mentioned tubes sell for $5.00, $3.00, and $3.00 respectively. The 200-A is fully dealt with in laboratory sheet No. 11 in this issue of RADIO BROADCAST. Apco is making a 201-A type double life tube (two distinct filaments) that is reminiscent of the two filament audiotrons of 1918. The characteristics of these tubes, and their application to receiving circuits, will be discussed at greater length in a later article.

The amplifying apparatus of the 1926–27 season shows a marked improvement over that of preceding years. The better transformer manufacturers are still holding their own (in the favor of the general user). AmerTran, Rauland Lyric, General Radio, Pacent, and Karas to mention a few, are perfecting their products with untiring effort, while resistance coupling has assured itself of permanent favor. For all that, the writer is of the opinion that the trend of engineering thought, justified by results, and the manufacture of applicable choke coils by such well-known concerns as AmerTran, Thordarson, General Radio, National, and Haynes-Griffin, forebodes a powerful swing toward impedance-coupled audio amplification.

JUST ABOUT THREE YEARS AGO

We would have hailed the receiver depicted herewith as an example of modern beauty and efficiency. Nowadays our appetites have been whetted by more elaborate affairs, and more costly, such as those multi-tube receivers illustrated elsewhere in these pages

Among the transformer developments are the interesting tunable transformers of the General Instrument Company (price $10.50), and of the Wagner Radio Company, in which a variation of the mutual inductance of the windings enables the experimenter to match his transformers, within limits, to individual tube conditions.

The Donle-Bristol Company has designed a new coupling unit which, mechanically, would seem to be a cross between a coupling impedance and a low ratio transformer.

There are many recruits in the resistance-coupled field. Daven, Amsco, and Electrad are forging ahead in the manufacture of kits and parts, while Allen-Bradley, DeJur, Heath, and Daven, etc., are marketing complete three-stage units.

The most marked progress in the field of resistance coupling is the concerted effort on the part of a half-dozen manufacturers to produce an efficient low priced resistor. By efficient, one has in mind a resistive element capable of dissipating at least one watt of power without appreciable change in electrical characteristics, absolute permanence, and noiselessness. This research has practically eliminated the paper impregnated type of leak and resistor, which falls down on all three points; and has brought forth the Electrad metal resistor (a sprayed deposit on glass), the metal resistor manufactured by Arthur H. Lynch, Inc.; the Amsco "Metaloid" (a new element deposited spirally on an interior glass rod), and a new Daven resistor.

THE MARCH OF RADIO

By J. H. Morecroft
Past President, Institute of Radio Engineers

The Outlook in Radio Apparatus for the Coming Months

DURING the past year, many things have happened in the radio business. The changes, while less rapid than in preceding years, have in some ways, been more fundamental. The past year has seen several complete sets disappear from the market. Bankruptcy has overcome some of the formerly well advertised firms. It may loom for several more, before the present period of readjustment is completed.

The average buyer of radio sets knows little of their process of manufacture. It is true that some of the large manufacturers themselves make practically all of the parts which go into their completed product. But this is the exception and not the general rule. The radio set has suffered a great deal because of its diversified parentage. It is not unnatural that some manufacturer desires to purchase transformers, for example, where they are cheapest. Transformers are what he wants and the eighty-seven-cent kind is just eight cents better in his eyes than the one he can buy for ninety five cents. This rule, one more of human nature than of radio, has applied to the other components of a radio set.

The heading illustration shows the Marconi short-wave beam receiving station and some of the transmitting towers at Wilverton, near Cape Town, South Africa

However, there is the brighter side, and there are a few reputable manufacturers who endeavor consistently and steadily to improve their product. They expect to be in business next year as well as this, and so establish the kind of apparatus they can stand behind and guarantee. Their laboratories are manned by intelligent and experienced engineers who are capable of making constant improvement in their products. From these manufacturers, one gets sets of continually improving performance. But we are interested in concrete facts and not in theorizing about the morality of the radio business.

Simplicity of receiver control has been featured in the past year and will continue. The one-dial set, or the two-dial, is economically possible and is what the public is interested in. This means the user who buys a radio set complete. The home constructor does not favor single control.

We know of several laboratories whose engineers have made real advances in the design and construction of audio-frequency transformers. Several years ago, this was one of the poorest parts of a radio receiver. Probably even now, there is room for more improvement. With these improved transformers, the drums of an orchestra become audible. Perhaps in 95 per cent. of the radio receivers in use to-day, it is impossible to hear a note as low as that given by a drum. Better iron for the cores of our transformers is an important contribution which future laboratory work must develop.

We hear very little now about the "low loss" condenser; any really good condenser has losses so low compared to those of the other parts of the circuit that they are negligible. When this became generally known, the "low-loss" bunk of a year ago generally went into the discard. But a real advance has been made in condenser construction; we refer to the straight-line frequency form. The nearly equal spacing of stations which these new condensers give is an advantage not to be despised. Undoubtedly the s. l. f. condenser is with us to stay.

It seems very questionable if the horn speaker is ever again to find general favor in spite of the excellent development of it which the engineers of some of our companies have made. The disc or cone speaker, possibly much bigger than those we now use, will continue to be the favorite.

Better tubes are possible and will probably be on the market soon. Undoubtedly, the Radio Corporation will continue to lead in tube development, even if the patent situation should permit the wide exploitation of tubes by other manufacturers.

It is an expensive job to carry on real research work along these lines, and it requires more complete facilities, in men and materials, than any but the largest companies can afford. A better output tube is really needed. Several forward steps along this line have been made by R. C. A., but the goal is not yet reached. The present output tubes can easily be improved to five times their present worth. The increased plate current required by such tubes will make questionable the use of dry cells for the operation of their plate circuit and so the possibility of light socket power for the receiving set acquires new importance.

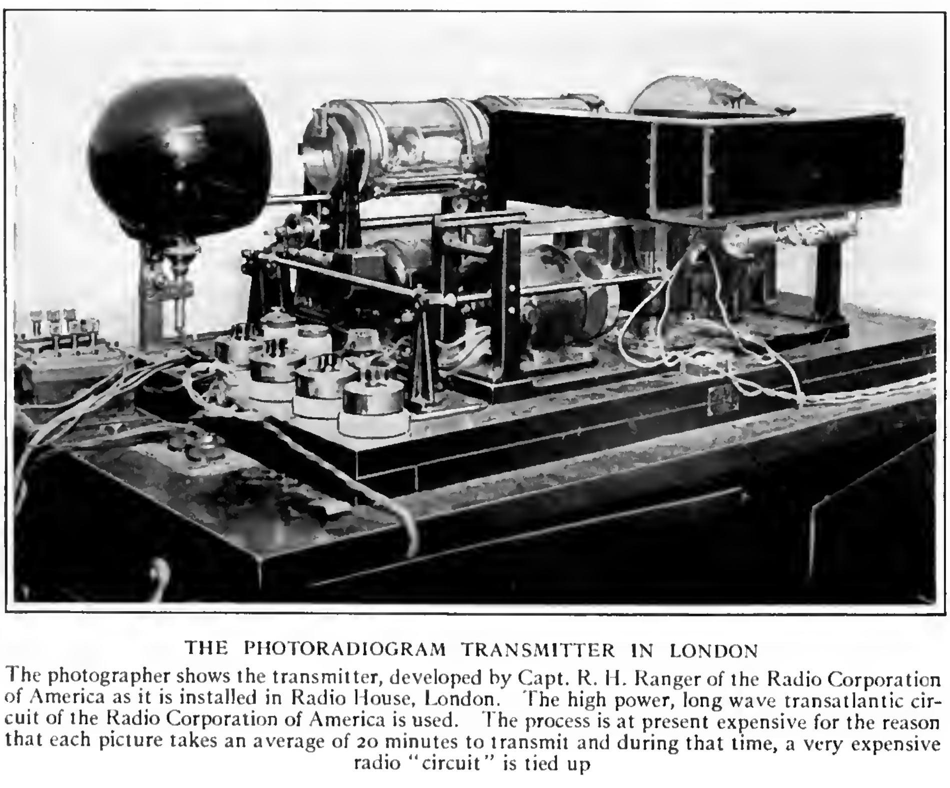
Probably this is the one important advance in radio reception which is disappointingly slow. To be sure, it is no easy task, but many good engineers are now working on it, and have been for some time, so that the hoped-for achievement may be realized in the not-distant future. From what we know about tubes, we believe that a possible output of five watts is required for satisfactory loud speaker operation and this certainly requires something other than dry cells. The five-watt tube would normally be giving to the loud speaker not more than one-twentieth of a watt, having in reserve a power one hundred times as much as this. This seemingly exhorbitant reserve is what is required for quality reproduction and certainly better quality will ever be the engineer's aim. Devices incorporating a power tube for the loud speaker, for operation from the light socket have recently appeared. They are to be used in addition to a radio receiver having one step of good audio frequency amplification and when so used, they perform very well indeed.

It is not impossible that some remarkable new types of tubes may appear on the market. Besides the "thimble tube" with the alternating current filament supply, and the shield grid tube with its remarkable amplification possibilities, even at very short wavelengths, it may be that someone will develop a tube which doesn't even require a heated filament. Theoretically it is possible, so someone may yet do it.

Seeing Things—By Radio

FOR many years, radio has proved of great help to the newspaper man. A quarter of a century ago, the then infant Marconi service kept landsmen informed as to the progress of the international sailing races off Sandy Hook. "*Via* Marconigram" had a most fascinating sound in those days; that the papers could be kept informed of the race by an observer miles at sea seemed indeed a miracle. But already the miracle, expanded a hundred times, has become commonplace.

But now another achievement signals that progress is being continually made, that the hopes and ambitions of at least a few radio workers actually are realized. The Radio Corporation has several times recently hinted that pictures would soon be coming across the Atlantic along one of its radio channels. It has now been done. Pictures are now being "regularly" sent from England to America. The first one took nearly two hours to send, but irregularities in the performance of the apparatus were rapidly eliminated and soon it was taking only minutes to flash across a recognizable copy of the picture three thousand miles away. One estimate places the time for transmission of a picture of ordinary size at twenty minutes. But of course this will depend upon conditions, primarily the amount of atmospheric disturbance existing at the time the picture is sent.



THE PHOTORADIOGRAM TRANSMITTER IN LONDON

The photographer shows the transmitter, developed by Capt. R. H. Ranger of the Radio Corporation of America as it is installed in Radio House, London. The high power, long wave transatlantic circuit of the Radio Corporation of America is used. The process is at present expensive for the reason that each picture takes an average of 20 minutes to transmit and during that time, a very expensive radio "circuit" is tied up

Naturally the cost of the service must at first be so high that only exceptional circumstances warrant its use. A great deal of valuable apparatus is being tied up to send the four-by-five, black and white prints, and someone must pay for the large overhead and development charges.

Crude as those first pictures are, the engineering staff of R. C. A. receives our hearty congratulations on the accomplishment and our best hopes for its improvement and increasing usefulness.

Coolidge and Hoover Oppose a Radio Commission

PRACTICALLY no criticism of any weight has been aimed at Secretary Hoover's control of radio up to the present. There are many who feel that to place the control of radio under one man is too autocratic a scheme to fit into our form of government.

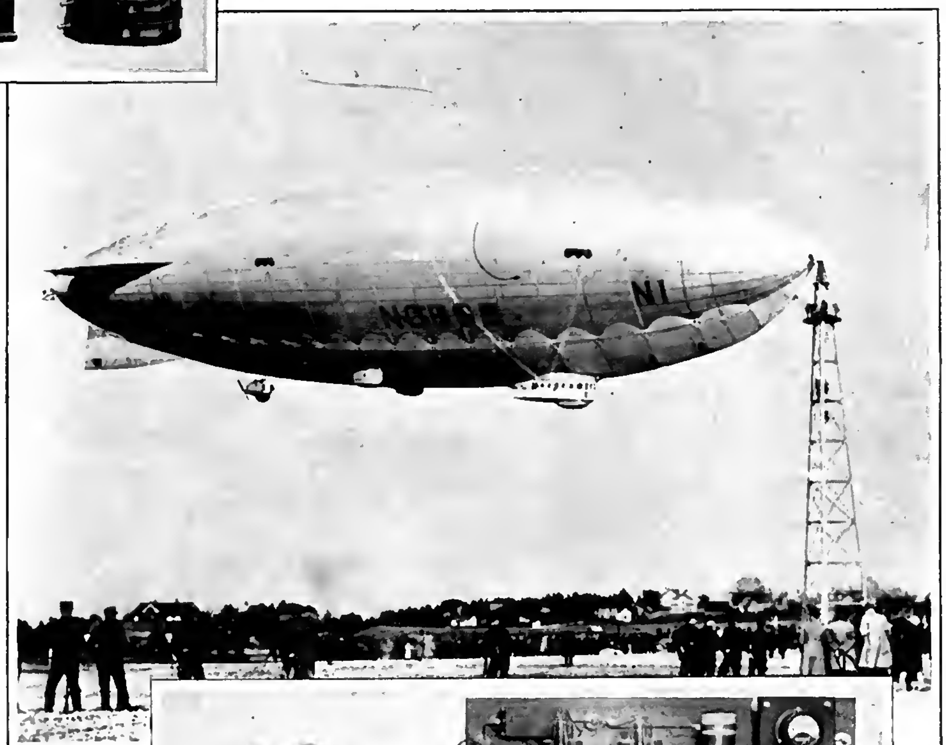
President Coolidge is said to believe that whatever commission may be created for radio regulation, their findings must be subject to his review and criticism. The Democratic floor leader, however, made the silly observation that such an arrangement "would mean full publicity for Coolidge's speeches, while political opposition would be deprived of the right to speak through the ether to the voters." It certainly is a fact that while Hylan was mayor of New York City, the Municipal Broadcasting station was used in that manner. What control there is over radio must assuredly be non-partisan. Whether Republican or Democrat be in power, the other party must have equal opportunity to use the ether channels. In closing his remarks Senator Robinson says "Whatever be the evils, the remedy is not to concentrate in the White House the authority of complete control."

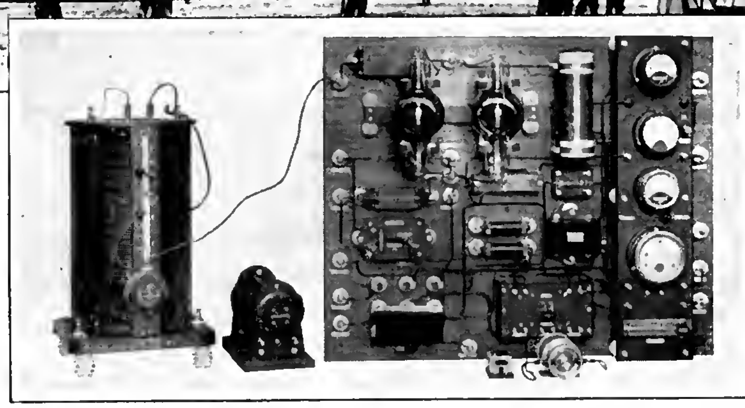
But Secretary Hoover says:

> Boards and commissions, by their divided authority have always been a failure in administration; they are desirable for discretionary or judicial determination. The tendency to create in the government independent agencies whose administrative functions are outside the control of the President is, I believe, thoroughly bad.

The Secretary of Commerce commended the members of his staff who have worked very hard on the radio control problem, trying to solve by tact and diplomacy situations in which the law gave them no real power to act. And, said he "so far as the Department of Commerce is concerned, the extraordinary difficulties and conflicts in the situation are such that we will be well satisfied to see radio administered by any other department which can properly undertake its regulation."

One fears that the Senate proposal to establish a five-man radio commission, with exclusive control will merely provide five more political jobs and greatly decrease





THE AMUNDSEN–ELLSWORTH AIRSHIP "NORGE"

The center illustration shows the ship at her mooring mast at Oslo, enroute for the North Pole which was successfully crossed. The ship successfully completed the epoch-making voyage, landing at Teller, Alaska. Direction-finding loops, fitted diagonally around the outside of the envelope and "doped" to the fabric with linen tape, can be seen coming together underneath the gondola. The top illustration shows the Marconi tuner, range 300-25,000 meters (1000-12 kc.) Eleven coils are used to cover the band. The ship also has a short-wave receiver to receive from Point Barrow, Alaska. The lower illustration shows the Marconi type "U" ½-kw. transmitter, specially mounted on a board for lightness and ease of mounting

the efficiency of all radio supervision and control. Can Congress point to any "independent" commission established by them which has really been a success?

Radio Sets Are Still Being Built At Home

THE Milwaukee *Journal* has sent us an extremely interesting and reliable analysis of the radio situation in that town and one of the most interesting sections of the report has to do with the home builders. Set manufacturers frequently state that practically all radio sets installed nowadays are factory-made but certainly this is not so in Milwaukee. In the year just past Milwaukee families bought 20,000 factory made sets and the astonishingly large number of 8000 were made at home.

The questionnaire from which the above information is gleaned had to be returned to the bureau at the *Journal* office personally, so that there was no chance of getting a stuffed ballot. The housewives to whom the questionnaire was sent were urged to return them properly filled out by promises of grocery samples (free), and other such inducements. From twenty thousand names circulated, four thousand questionnaires were returned.

Crystal sets are rapidly disappearing. Only 1.7 per cent. of Milwaukee's listeners use receivers of this kind. Radio sets in combination with phonographs have found practically no market. More than 53 per cent. of the sets use five tubes, but last year only 22 per cent. used this number of tubes. Most of the new five-tube sets are apparently the outgrowth of three-tube sets because the number of such sets show a decrease from last year's figure of 36 per cent. to only 15 per cent. this year. Apparently an extra radio frequency stage for distance getting and an extra audio stage for loud speaker operation has proved desirable to thousands of Milwaukee's radio fans.

More than 67 per cent. of the receiving sets operate loud speakers; most of them are of the horn variety, only 2 per cent. of the receivers being as yet equipped with cone type speakers.

Battery eliminators have not found great favor in this locality as yet. Less than one half per cent. of the listeners use A and B battery substitutes. Even B voltage supply units have not yet proved popular, as 3.5 per cent. of the listeners prefer them to batteries. Milwaukee is as yet a fruitful field for the dry cell and storage battery man, but from the statistics it looks as though a reasonably priced, reliable plate supply unit would make a mint of money for the progressive dealer.

British Broadcasting

IT IS interesting to note that at the same time there is talk of rearranging the governmental control of our radio, the same question has arisen in Great Britain. There, a private company, the British Broadcasting Company, has been granted a monopoly of broadcasting. From the press comments, we judge that their work has been well done. It speaks well for a monopoly of this sort when the public is so ready to praise its work.

The contract with the B. B. C. runs until 1927. In anticipation of the expiration of this contract, the Postmaster General appointed a committee to study and report on the radio situation with recommendations as to carrying on the broadcasting when the B. B. C.'s contract terminates. This report advocates the formation of a commission to be constituted of five to seven members appointed by the Crown to serve for five years. The commission will be responsible for carrying on the entire broadcasting activities in Great Britain. The money annually collected by the Postmaster General ($2.50 for each receiving set) will be turned over to the commission up to a certain amount—the surplus will accrue to the Postmaster General's bureau. This one feature receives condemnation and well it may. When a listener pays his ten-shilling license fee, he is paying for radio, not to help out a possible deficit accumulated by the mail service. All of the license money (except that required for administration work in the Collector's office) should be turned over to the commissioners for program and development work.

It is anticipated in any case, that the new body will take over the staff and apparatus of the B. B. C. "as is"—there is to be no interruption in the broadcasting while change of title is taking place. There are at present ten principal stations and eleven more of lesser power being operated by the B. B. C. and it is expected that several of higher power will be erected by the new commissioners, to take the place of the many low power ones.

One Share of Stock = One Radio Set

A CAREFUL report by Dow, Jones and Company of New York shows how much of the public's money has been lost in radio. The stocks of all the radio companies have gone down with a bang during the past year, and some of them hit bottom altogether.

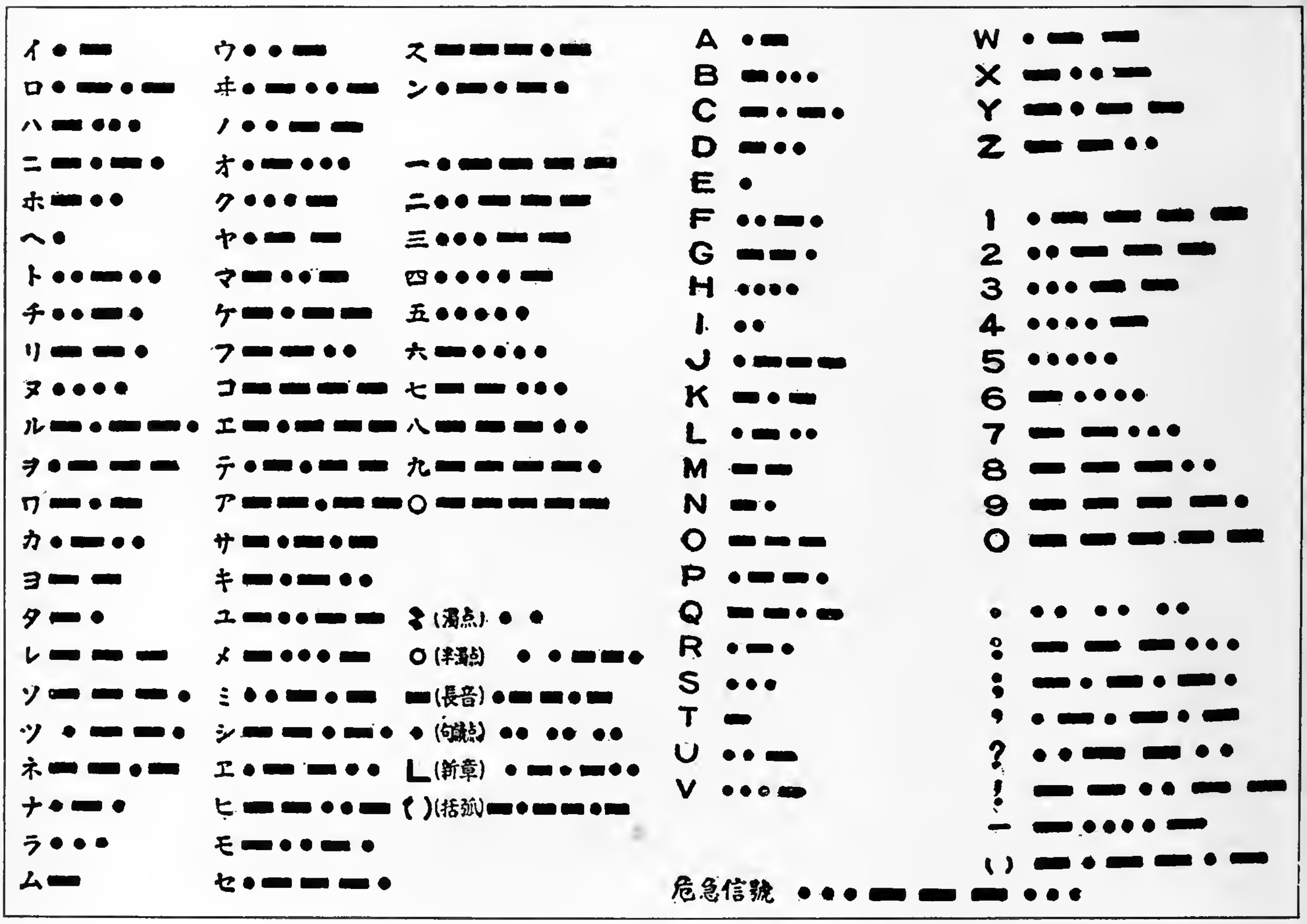
To the credit of some of the houses which floated this stock it must be reported that note was always made regarding the gambling feature involved in investments of this sort. And gamble it certainly was, for during the past year the shrinkage in value of radio stocks reached nearly one hundred million dollars.

Dow, Jones, and Company report that during 1924 for every receiving set sold, at least one share of stock in some radio company was sold. Where the money which the public sunk in this way went to is a mystery to one not having access to the books. The Music Master Corporation, for example, was valued at $10,000,000.00 during 1925, and now this stock has a market value of $67,500.00. A tabulation of the radio stock market for the year's period gives some interesting data. For the benefit of those whose capital has shrunk so rapidly in some of these companies, we give a list of the more important companies which have been listed on the exchange so that they can see to what extent their neighbors have also suffered.

Name	Total Shares	Value Dec. 1924	Value To-day
Music Master Corp.	450,000	$ 9,675,000	$ 67,500
D. Grimes	235,000	6,345,000	254,583
De Forest Radio	208,208	5,413,408	208,208
Dubilier C & R	134,450	9,108,988	537,800
Duplex C & R	62,500	765,625	46,878
Freed-Eiseman	300,000	9,800,000	1,200,000
Hazeltine	175,000	8,400,000	1,375,000
Inter-Ocean	100,000	1,262,000	100,000
Jones Radio	225,000	1,771,875	112,500
Liberty Radio	120,000	960,000	12,000
Rad. Corp. of Am. co.	1,155,400	71,204,450	41,594,400
Rad. Corp. of Am. pf.	395,597	19,771,850	17,801,865
Rova Radio	75,000	900,000	37,500
Sl'per Radio	110,000	1,870,000	27,500
Garod Radio	150,000	1,775,000	545,000
Thermiodyne	250,000	4,812,500	120,000
Thompson	127,100	2,621,438	195,000
Tower Mfg.	87,500	1,966,500	812,500
Ware Radio	75,000	2,943,750	37,500
Total	4,433,755	$161,367,384	$65,085,734

RCA Takes Out a License

THERE are very few patents of value in the radio field to-day which the R. C. A. does not control through its license agreements with the large electric companies. The idea of the R. C. A. condescending to take a license to make



RADIO CODES THEY USE IN JAPAN

Japanese radio operators have to be conversant with the International Morse Code—that is, the "Continental" and a special code of their own, shown in the first three columns. Note how sos is written in the Japanese ideograph. The three dots, three dashes, three dots below the extreme right hand columns are sos in any language, but it takes four Japanese characters to indicate the signal. The ten numerals, with their Japanese equivalents are shown in the third column. The cut is reproduced from *The Radio Experimenter*, Tokio any radio apparatus is somewhat unusual, but to think of them paying $200,000 for the privilege is still more so.

Yet that is what has happened, according to a well authenticated report. Some of the fundamental patents on the cone type speaker are owned by the Lektophone Company, in which Hazeltine's patent attorneys appear to have a strong interest. The new cone speaker, which R. C. A. has been putting out, comes near enough to infringing some of the Lektophone patents that the Radio Corporation has apparently thought its most profitable course was to settle any possible disputes with the tidy sum mentioned above.

We understand also that the Western Electric cone speaker is due for a patent suit from the Lektophone Company.

Street Lighting and Radio Reception

IT WASN'T very long ago that most of the smaller towns in the United States had their streets lighted by arc lamps; we liked to hear them hiss when the carbons fed together and we used to gather the discarded carbon rods to make wet batteries. This arc lamp scheme of street lighting was very bad in so far as interference with other circuits was concerned. Telephone companies especially looked on it with disfavor.

In most cities, the old fashioned arc lamp has been displaced by the small tungsten filament lamp, which burns on ordinary alternating current with but very little commotion. But in Butte, Montana, the rugged miners still stand for the pioneer lighting scheme. As miners it was good enough for them, but as radio fans they demand something better. The disturbances from the arc lighting system interfere seriously with radio reception so the lighting company has been asked by the Butte radio club, a laudably active organization, to renovate its system. The company estimates it will cost them $12,000 to change to a modern lighting scheme.

One Way to Kill the Bloopers

ANY way to rid the air of the blooper's whines is welcome. The Sterling Electric Company of Minneapolis has run an advertisement offering a five-tube t. r. f. set for sixty dollars, on which they will allow $17.50 for a one-tube regenerative outfit and correspondingly more for regenerative sets using more than one tube. Says the ad, with respect to turning in the old squealer, "Keep the accessories. All we want is your old trouble-making set. All sets turned in will be destroyed."

More power to the Sterling Company—providing its own five-tube sets don't oscillate into the antenna. This idea might well be taken up by other radio dealers. The appeal to the regenerative set user is practical—which is the only way in which practical results—what we are all after, can be obtained.

More Tractors Than Radio Sets On American Farms

THE farmer who uses a tractor to haul his plows and harrows shows appreciation of the value of modern devices and also sufficient prosperity to follow the suggestions arising therefrom. When we consider the value of a radio set to the farmer, both from the standpoint of market reports and weather predictions, as well as from that of the evening's entertainment and amusement, it seems as though there should be at least as many radio sets on our farms as there are tractors. But that is far from being the fact.

The Department of Commerce has just given out as part of its 1925 Farm Census a comparison of tractors and radio sets on the farms throughout the country for 1920 and 1925. The total number of farms in the United States in 1925 was 6,371,617. Of these 474,694 had one or more tractors, and only 284,053 had radio sets.

Interesting Things Said Interestingly

C. B. SMITH (Chicago; president, Stewart Warner Radio Corporation): "For the most part radio's early exponents were well meaning gentlemen recruited largely from the shoe trades and the marts of the cloak and suit. These opportunists might have had trouble distinguishing between a variometer and a B battery, and they thought that induction was something punishable by law in all states except Nevada, but they knew that this radio thing in its little pine box, through some operation of legerdemain quite beyond their ken, was making music without a record or a motor. Obviously, a thing capable of such wonders was a thing capable of virtually limitless opportunity. Most of the pioneers looked upon the crystal set as a device that must ultimately give one the wrong numbers, now so essentially the stock in trade of the wired telephone. They did not attempt to analyze the means by which this would be brought about. It was enough for them that a crystal set could be constructed of bell wire and cardboard tubing, and sold to the gullible public for $25—a haphazard prognosis that might well have then expected to produce the haphazard industry that it actually did produce."

DR. J. H. DELLINGER (Washington; Chief of the Radio Section, Bureau of Standards) "There is no longer any more reason for waiting to buy a good radio set than there is in waiting to buy a good piano. While there doubtless will be occasional refinements in receiving equipment, these are not likely to affect appreciably the comparative value of the standard sets of to-day. Tubes, of course, will lose their efficiency after from 1000 to 2000 hours of use, but most of these can be reactivated at small cost. The set as a whole, however, will retain its efficiency and value indefinitely."

T. P. O'CONNOR, M. P. (London; discussing the desirability of broadcasting the Budget Speech, in the *Radio Times* London):

". . . You will see on a Budget night the post office assailed with scores of members sending telegrams to their friends or their partners announcing the provisions of the Budget. This is inevitable, as these great businesses have at once to accommodate themselves to the new conditions.

"Now what I want to ask is, why this most valuable and necessary information in the business of the country should be kept back for one second longer than it is necessary? The evening newspapers are able to cover a certain amount of the ground, of course, and the morning newspapers, next day, all the ground; but why should millions of people living in districts remote from evening newspapers be handicapped in their preparation for the future of their business by being denied the information which broadcasting could give them immediately? There are millions of people outside London whom even the latest editions of evening papers cannot reach with this most necessary information.

"I protest against the policy that would leave in the darkness of perilous ignorance those millions of people to which the broadcasting could bring light and knowledge."

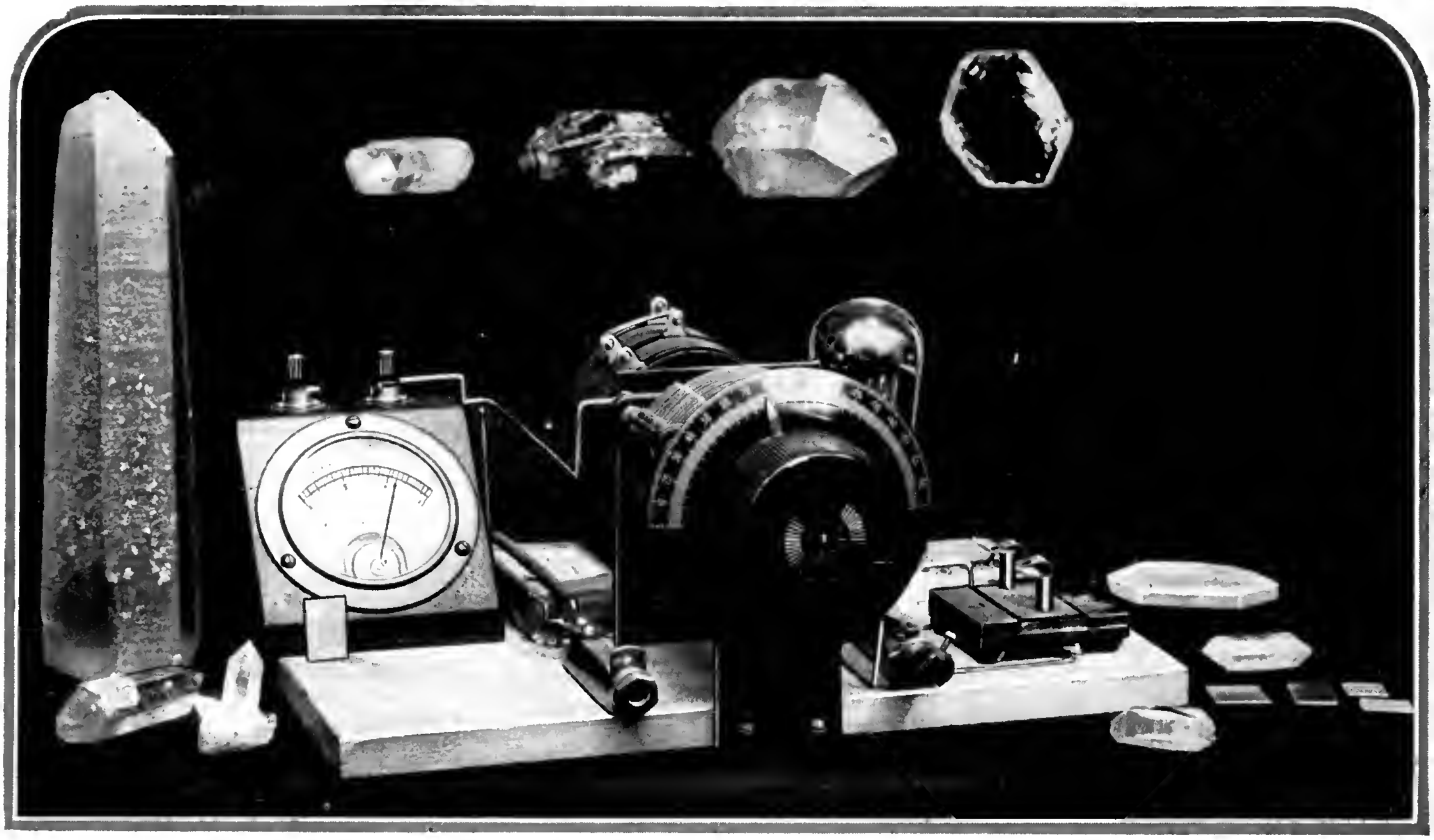
FRANK B. NOYES

Washington

President of the Associated Press:

"News is flashed across the water by both cable and wireless, all available transmitting means being employed, although the fastest and most reliable naturally get the bulk of the service. Sometimes conditions are highly favorable to the use of wireless, and then this method of transmission is employed extensively. At other times, trouble on the air route requires a shift to the more stable underwater channel. In the case of highly important bulletins, nothing is left to chance. Big developments are flashed both by radio and cable. Wireless communication with South America is not as yet so dependable as is the service between Europe and the United States."

A. ATWATER KENT (Philadelphia; radio manufacturer; especially written for RADIO BROADCAST): "The precision in the manufacture of radio receiving sets now attained, together with constantly improving radio programs, make for increased popularity of radio. The estimated five million receiving sets now in use will be greatly augmented in the near future. I believe a great increase in the number of sets will be noted on farms, where the isolation of farm life gives to radio a more practical value than in the city. There will certainly come a greater use of radio in education, not only in school rooms but in educational uses in the home.



RADIO BROADCAST Photograph

WHAT QUARTZ CRYSTALS LOOK LIKE

Quartz plates are coming into their own as standards of frequency. Papers are delivered before the learned societies, articles are written in magazines, and the world is scoured for clear quartz crystals. These crystals were furnished the Laboratory through the courtesy of Mr. Robert F. Collins, of Columbia University. The instrument is a heterodyne wavemeter

Wavemeters for the Home Laboratory

Another Helpful Article for the Home Experimenter—Simple and Inexpensive Meters and Their Use—The Extremely Useful Heterodyne Wavemeter—How to Calibrate All Types of Wavemeters

By KEITH HENNEY

Director, Radio Broadcast Laboratory

ONE of the earliest and most laudable desires of the home experimenter is to measure something. He knows that the meat of any research lies in the data obtained from a succession of experiments, and that these experiments are marked almost entirely by the business of making measurements. This article, which is one of a series of several for home experimenters, describes the simplest and perhaps most fundamentally useful part of a radio enthusiast's laboratory—a means of measuring frequency or wavelength.

In the good old days, such instruments were termed wavemeters and even now, when we speak of frequency instead of wavelengths, it is common practice to hear engineers speak of wavemeters and kilocycles in the same breath. Regardless of the appellation of the apparatus, however, there is little doubt that the simplicity and usefulness of a wavemeter recommend it as one of the first measuring instruments to be made for the home laboratory.

Other articles in this series have described a simple oscillator and its uses as well as standards of capacity and inductance and a bridge by which unknown coils and condensers may be compared. Future articles to appear promise experiments upon coils and condensers, tubes, and meters, many of which are based upon actual work carried out in the RADIO BROADCAST Laboratory as well as experiments indicated by reading the Bureau of Standards Bulletin 74 or the Signal Corps book, *Principles Underlying Radio Communication*.

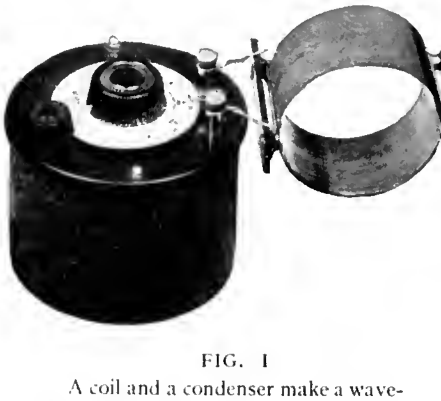


FIG. 1

A coil and a condenser make a wavemeter as this photograph shows

It has already been mentioned that a wavemeter is a simple piece of apparatus. In fact, the first wavemeter the home laboratory worker should make is composed of but two units, a coil and a condenser. Who is the experimenter who has not an idle condenser, lying about the laboratory, and where is he who can not wind a few turns of wire on a form of some sort?

With such a meter one can do the following things:

1. Measure the frequency of received signals.
2. Measure the frequency of transmitted signals.
3. Set a receiver, or transmitter, to a given frequency.
4. Trap out unwanted signals.
5. Measure frequency in laboratory experiments.

Fig. 1 shows the complete simplicity of such a wavemeter. The inductance in this case is part of a Hammarlund-Roberts antenna coil, composed of wire wound on a thin cellulose form, each wire separated from its neighbor by about the diameter of the wire. It makes a coil of very low loss, and the wavemeter will, for this reason, tune sharply.

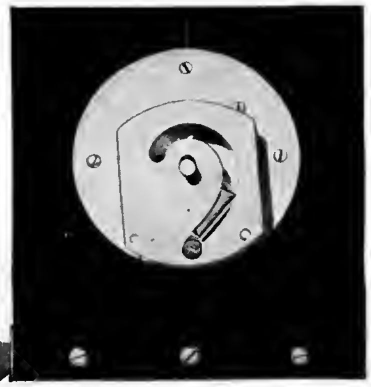
A low loss coil is not at all necessary for a wavemeter—in fact, what is really wanted is rigidity, so that once the meter is calibrated the owner has the certainty that he will not have to recalibrate it because the coil drops on the floor. For this reason, rather large wire—say No. 20 bell wire—wound on a good form is to be preferred to a more flimsy but low loss type.

The condenser may be any variable capacity. If the meter is to be calibrated in kilocycles, which is advisable, the condenser should be of the straight line frequency type, but that is not necessary, for if such a characteristic is wanted one of the straight line capacity condensers may be fitted with a special frequency converter dial—like the Rathbun dial illustrated in Fig. 2. Even this is not necessary, for once the meter is calibrated, wavelengths in meters may be converted to frequency in kilocycles by the simple process of dividing 300,000 by the wavelength in meters. For example, 600 meters equals 500 kilocycles.

The condenser, however, should be of sturdy construction and well protected from dust and from mechanical injury. The General Radio "can" condensers lend themselves well to this purpose, and Fig. 3 is a General Radio wavemeter and wave filter (trap) which is very useful. The dial is calibrated in wavelengths, 200 to 600 meters.

The leads to the coil-condenser combination should be short and heavy, and when the wavemeter is equipped with several coils to cover different frequency bands, a plug-in arrangement is useful. At any rate, the device must be calibrated with the leads connected to it as it is to be used later, and each time the leads are changed, a new calibration must be made.

To calibrate such a meter is simplicity itself. One moves the coil near a receiving set that is in operation. The wavemeter is tuned until signals from a known broadcasting station—which is probably pretty near its assigned frequency and which is being heard in the receiver—disappears. This indicates that the meter is tuned to that frequency and is absorbing energy from the receiving set. By noting the condenser scale for several stations the frequencies of which are known, a complete calibration may be obtained.



Radio Broadcast Photograph

FIG. 2

If one has a straight line capacity condenser—and who hasn't?—he may get an approximately straight line frequency graph by using this Rathbun converter which is a dial having an eccentric cam arrangement attached to the shaft receptacle

Radio Broadcast Photograph

FIG. 3

The General Radio company makes a wavemeter that can be used as a filter too, and this photograph gives an idea of its appearance. The condenser is calibrated in wavelengths from 200 to 600 meters

A curve can be made by plotting on a sheet of graph paper the condenser degrees against the frequency in kilocycles, or wavelength in meters. For example, in the Laboratory, the Hammarlund-Roberts-General Radio combination tuned as Table 1 shows; and in Fig. 4 is the chart showing how such data is plotted.

Table 1

STATION	WAVELENGTH	CONDENSER DEGREES
WNYC	526	90
WEAF	492	78
WJZ	455	65
WOR	405	51
WHN	360	40
WPG	300	28
WFBH	273	24
WBNY	210	14

It will be found that some stations will not fall on the curve. This indicates that the station in question has strayed from its assigned frequency. There are few localities, however, where one may not hear at least one of the stations in Table 2. These are very close to their assigned frequencies as indicated by recent reports of the Bureau of Standards. At any rate, a curve should be drawn through as many points as possible and naturally, the more points, the more accurate the curve.

TABLE 2

STATION	FREQUENCY	AVERAGE DEVIATION *Per cent*
WJR	580	0
WEAF	610	0
WCAP	640	.1
WRC	640	.1
WSB	700	.2
WGY	790	.1
WBZ	900	.1
KDKA	970	.1

So much for the construction and calibration of the simplest wavemeter, a tuned coil-condenser combination. We shall return to more accurate methods of calibration later.

There is another simple wavemeter that is used at 2 GY, the scene of the Radio Broadcast short-wave experiments. This meter has been described by the Bureau of Standards and is composed of the components described above together with a method of indicating resonance. It is essentially a meter to be used at a transmitting station, and a photograph is shown in Fig. 5. Coupled to the coil of this wavemeter is a pick-up circuit in which is a crystal detector and a milliammeter or small flash light bulb.

The purpose of placing the indicating device external to the circuit is to keep the resistance of the tuned circuit as low as possible. What actually happens is as follows: Currents of radio frequency are picked up from the transmitter and flow around the tuned circuit. The pick-up circuit gets its energy from the coil-condenser circuit and after this current is rectified, the d. c. component is measured by the milliammeter or the flash lamp. The circuit is shown in Fig. 6.

HETERODYNE WAVEMETERS

THERE is another type of wave or frequency meter that is vastly more useful than the simple ones just described. This is known as a heterodyne wavemeter, and is really a small receiving—or transmitting set—in which resonance is indicated by a pair of telephones or a milliammeter.

The radio-frequency oscillator which was part of the modulated oscillator described in the first article in this series (September, 1925) may be used with the addition of a jack in the grid or plate circuit of the tube. A separate tube, however, may be rigged up with its accessory apparatus and with the modulated oscillator many interesting experiments may be performed, for here are two miniature transmitters, one of them modulated, and with proper jacks one can listen in either circuit, noting what changes take place as the two transmitters are tuned alike. Or one can listen in his receiver and, setting the two oscillators 10,000 cycles apart, ascertain if his receiver is selective enough to separate two stations tuned to within 10 kilocycles of each other. The note heard in the receiver will serve to show the experimenter the origin of "heterodyne" squeals now in the ether on short-waves. If the receiver can separate two signals 10 kilocycles apart, it may be considered sufficiently selective.

A jack placed in the grid or plate circuit of the modulated oscillator has several important uses. In the first place a milliammeter may be plugged-in these circuits and the effects of tuning noted,

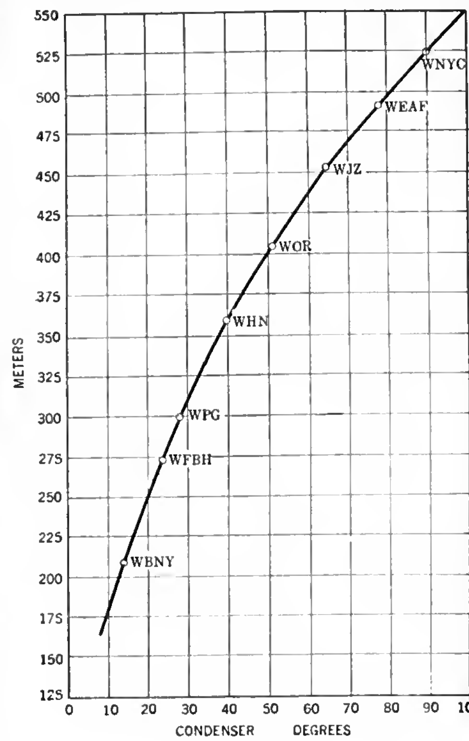


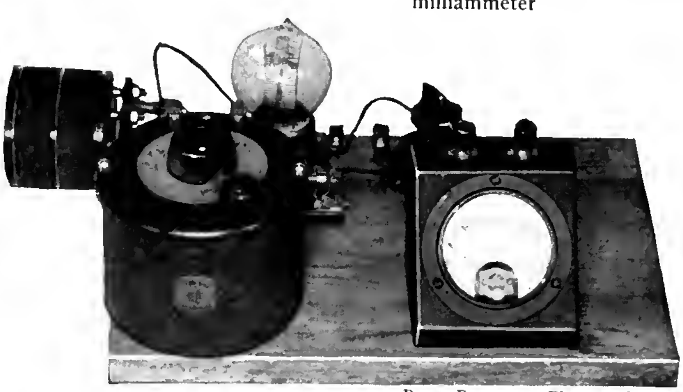
FIG. 4

The coil-condenser combination of Fig. 1 tunes as this graph shows. Knowing the wavelength of a station one can easily read from this chart the condenser degrees to tune the wavemeter to it

Radio Broadcast Photograph

FIG. 5

An oscillator, a short-wave transmitter, and a wavemeter all in one picture. The transmitter is being tuned by means of the wavemeter which is first calibrated against the Laboratory oscillator. When the transmitter is properly tuned, the wavemeter picks up energy which is indicated on the milliammeter



Radio Broadcast Photograph

FIG. 7

An experimental heterodyne wavemeter that is also a laboratory oscillator. When this circuit is tuned to another near by, a deflection of the plate meter shows the exact point of resonance. The device is also an excellent source of high frequency current for laboratory experiments

and in the second place, a pair of receivers plugged-in the plate circuit will indicate resonance with some tuned circuit by a decided "thump."

A very sensitive instrument may be made if a milliammeter with a full scale reading of 1.5 milliamperes is used in the grid circuit. If a plate meter is used it must be able to read 5.0 milliamperes. The grid meter arrangement is more sensitive, but has the disadvantage that the meter is more expensive. Whether the milliammeter is placed in the grid or plate circuit it should be by-passed with a 0.006-mfd. condenser. It may be permanently connected or plugged-in as indicated.

An experimental laboratory set-up is shown in Fig. 7, and a photograph of the Laboratory heterodyne wavemeter in Fig. 8. A WD-12 tube is used in this instrument and batteries are provided within the cabinet so that the whole outfit is easily portable. Any tube may be used, although for reason of portability, the dry cell operated ones are to be preferred. If more power is desired, it is only necessary to use a larger tube with higher plate voltages. The meters must be shunted to avoid damage and a new calibration will be necessary if the B potential is increased.

USES FOR THE METER

THERE are many uses to which this form meter is adaptable. For example, let us suppose that we wish to measure the frequency to which a coil-condenser combination is tuned. The inductances of the circuits are coupled together, not too closely, and the wavemeter condenser varied. When the two circuits are tuned alike, a sharp deflection of the grid or plate milliammeter

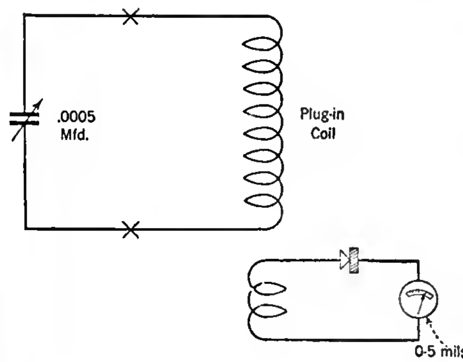


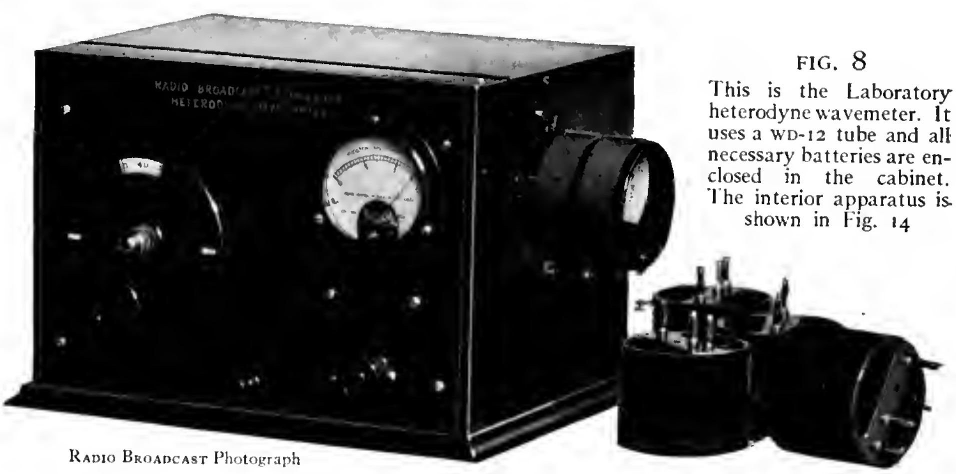
FIG. 6

A circuit diagram of the wavemeter used at 2 GY and illustrated in Fig. 5. The crystal detector rectifies the energy picked up from the transmitter and the resulting d.c. current is read on the milliammeter

will indicate resonance. Coupling between the two circuits should be only tight enough so that a slight dip occurs in the milliammeter. As a matter of fact, a tuned circuit a foot distant from a heterodyne meter will produce a decided deflection.

A pair of phones inserted in the jack of the meter will give a sharp click when the circuits are tuned to each other, and, if desired, the grid or plate milliammeter may be dispensed with and resonance indicated only by the telephones. In this case, however, somewhat closer coupling must be used. The graph, Fig. 9, shows how the plate, or grid current meter varies as resonance is approached.

The circuit of this interesting and sensitive indicator of resonance is the Hartley, as shown in Fig. 10. The polarity of the battery does not matter although it should be reversed before permanent connections are made to determine which is better. Plug-in coils may be used, as shown in Fig. 8 and, with a set of General Radio inductances, frequencies between 500



Radio Broadcast Photograph

FIG. 8

This is the Laboratory heterodyne wavemeter. It uses a WD-12 tube and all necessary batteries are enclosed in the cabinet. The interior apparatus is shown in Fig. 14

and 6000 kilocycles may be accurately measured. Other plug-in coils are made by Aero Products, Inc., Chicago; Radio Engineering Laboratories, New York, and others.

The tube of this circuit oscillates at the frequency determined by the inductance and capacity of the tuned circuit, and when another tuned circuit is brought near it, energy is extracted from both grid and plate circuits so that the current changes.

By means of the click as heard in the phones, or by the dip in milliammeter, the frequencies of receivers, of tuned circuits, natural wavelengths of antennas, or coils, may be measured with an accuracy that depends entirely upon the accuracy with which the meter is calibrated and the mechanical accuracy with which the dial can be set and read.

A QUARTZ CRYSTAL METER

THERE is still another type of wavemeter that has come in for much attention during the last few years. This is the wavemeter employing a quartz plate which acts as a standard of frequency. It is perhaps the most satisfactory standard of frequency that modern science has produced, for once the plate is cut and ground to the desired thickness, its frequency will not vary.

Such quartz crystals are connected to a wavemeter is one of the ways shown in Fig. 11, and

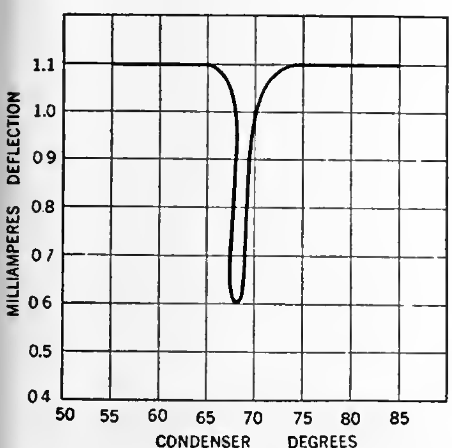


FIG. 9

When the heterodyne wavemeter is tuned to an absorbing circuit near by, the plate-meter "plops" in a curve similar to the one in this illustration. If one listens in the plate circuit at the same time, he will hear a distinct click as the point of resonance is passed through

clamped between two metal plates. The photograph at the top of the first page of this article shows such an arrangement. The crystal is held in the small gadget resembling a fixed condenser on the extreme right of the baseboard. An explanation of this phenomenon, one of the most interesting in modern science, may be read on Page 116 of the June Radio Broadcast, and is by Professor Morecroft.

The tuning condenser in a quartz-crystal-controlled oscillator or wavemeter may be varied over several degrees without the actual frequency of the system varying. In other words, the quartz plate acts as a frequency stabilizer. In practice the quartz which is held between two metallic plates forming the electrical contacts of the frequency stabilizer merely defines one point on the frequency curve very accurately, and one can tell from time to time if the calibration of the wavemeter has changed by noting this one point. If often happens that some slight change in tube constants or leads, may shift the entire curve of a wavemeter, and by noting where the quartz crystal frequency appears on a new curve, the corrections may be made. Several most valuable articles on this subject have appeared in the radio press recently. The Bibliography with this article lists the more important. Quartz crystals may be purchased from the General Radio Company, Scientific Radio Service, Mount Rainier, Maryland, and others.

HOW TO CALIBRATE THE WAVEMETER

THE simplest method of calibrating a meter has already been described. It consists in absorbing energy from a non-oscillating receiver by

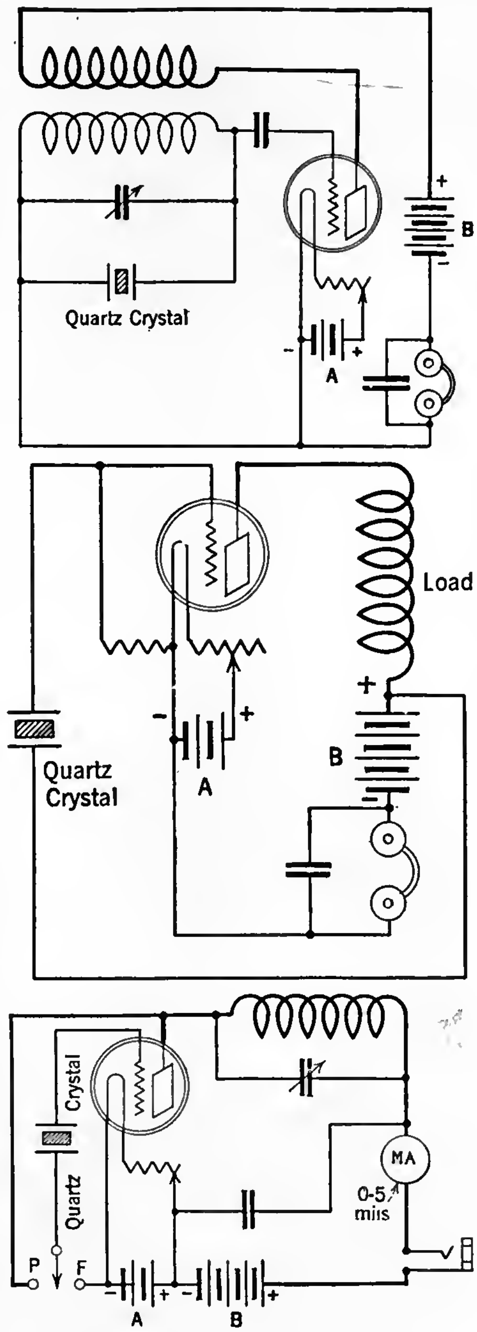


FIG. 11

As standards of frequency, there are nothing like quartz plates, as Professor Morecroft explained in the June Radio Broadcast. Here are a few circuits which utilize quartz, and others may be found in a recent paper before the Institute of Radio Engineers by August Hund of the Bureau of Standards

the wavemeter and noting the decrease in signal strength in a pair of telephones. Another, and more accurate method, is by means of the "click" of an oscillating detector such as that in the Roberts, the Browning-Drake, etc. If there are two clicks, or if the exact resonance point is not sharp, the coupling is too close.

Let us suppose that we wish to calibrate a simple coil-condenser combination. We rig up a single-circuit "blooper" detector and by listening as usual with a pair of telephones, tune to some broadcasting station whose frequency we know. Suppose it is WEAF operating at 610 kilocycles or 492 (approximately) meters. The detector is tuned to exact resonance with WEAF by means of a vernier condenser. One method of doing this is shown in Fig. 12, in which a Haig and Haig condenser with an additional plate is utilized. The main condenser is tuned as closely as possible to 610 kilocycles and a strong beat note will result. Then the single plate is tuned until this beat note disappears. We are then certain that the detector is operating at exactly 610 kilocycles. It should not be changed. Coupling to the antenna should be loose enough so that an accurate adjustment is made.

The wavemeter is then brought into resonance with the receiver, and the click noted in the receivers. This is one point for our wavemeter. Other stations can be received in the same manner and several points located on our curve

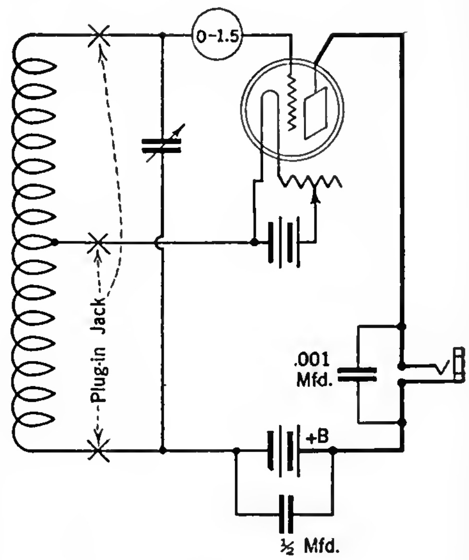


FIG. 10

The simple Hartley circuit of the oscillator-wavemeter

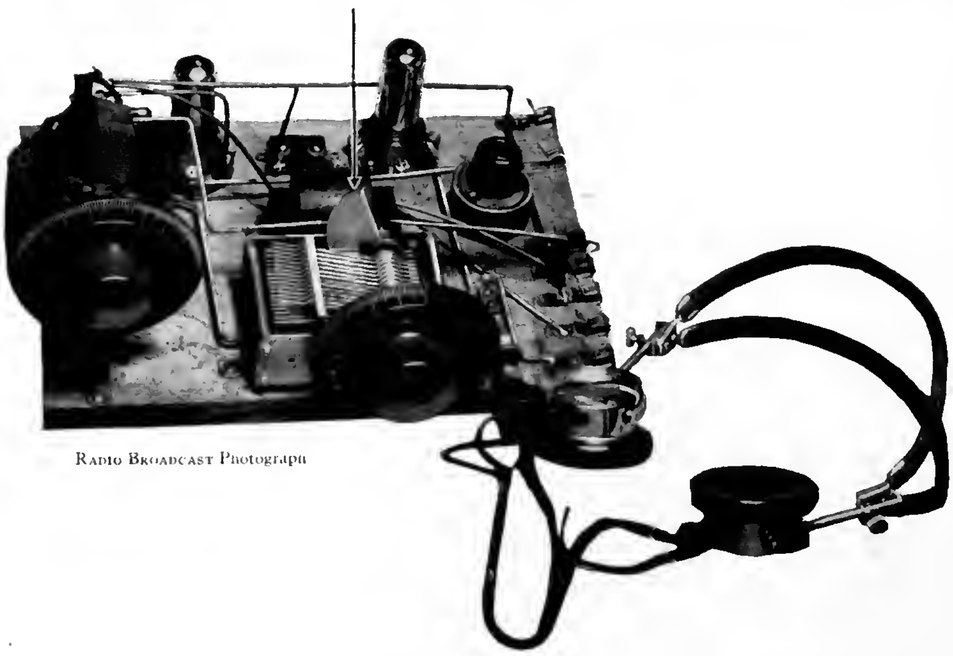
of frequency against condenser setting. If we are calibrating the heterodyne meter, it is only necessary to tune its condenser until the note emitted from it exactly coincides with that of WEAF or any other stations. Loose coupling must be used.

There is an alternative method that is very interesting and instructive, and when one comes to calibrate the higher frequencies (shorter wavelengths) this method is most useful.

CALIBRATION BY HARMONICS

THE method is one which utilizes the harmonics generated by an oscillating tube. A definite experiment will make clear the method.

We have already set our oscillating detector to 610 kilocycles. Now this tube not only generates a frequency corresponding to WEAF's wavelength but also generates other frequencies



Radio Broadcast Photograph

FIG. 12

A simple "blooper" that is useful in standardizing wavemeters. The arrow indicates the single plate of the Haig and Haig condenser that is useful in tuning to exact resonance with incoming signals

of twice, three, etc., times this frequency. In other words, if one could look at the output of this tube he would see frequencies as indicated below.

	FREQUENCY K. C.	WAVELENGTH METERS
Fundamental	610	492
Second Harmonic	1220	246
Third Harmonic	1830	164
Fourth Harmonic	2440	123
Fifth Harmonic	3050	98.5

Now, using a plug-in coil of about 60 turns on a 3-inch form for our first coil in the wavemeter, we may rest assured that with a 0.0005-mfd. condenser our frequency range will be 500 to 1500 kilocycles. Listening in our blooper receiver which is still tuned to 610 kilocycles, we may tune the heterodyne wavemeter, which is also generating harmonics, until it tunes to 1220 kilocycles when a loud beat note will be heard in the telephones. Here then are two points from a single station which will be as accurate as we are able, mechanically, to adjust our apparatus.

If we use 30 turns in the same length of winding on the second plug-in coil, it should tune to exactly one-half the wavelength, or twice the frequency, of the 60-turn coil, or 100 to 300 meters, 1000 to 3000 kilocycles. This will include the second, third, fourth, and possibly the fifth harmonics of 610 kilocycles. Listening in the receiver and tuning the heterodyne wavemeter, we shall hear beat notes whenever the meter is tuned to one of these harmonics. If the two instruments are too closely coupled, clear beat notes will not be heard, or it is possible that fractional harmonics may be found—which will be described later. A, 15-turn coil will double the frequency of the 30-turn one, and will tune from 50 to 150 meters or 2000 to 6000 kilocycles. This will include harmonics between the fourth and the tenth.

Thus by getting one single station tuned very carefully by means of a vernier adjustment, we may calibrate a whole series of wavemeter coils and our accuracy of calibration will depend upon three things, the accuracy with which the transmitting station is tuned to its assigned frequency, the accuracy with which we can set our receiver to its exact frequency, and the accuracy with which we can set the heterodyne meter and read the dials. There is an optional method which makes use of a short-wave receiver.

CALIBRATING WITH A SHORT-WAVE RECEIVER

SUPPOSE we tune our broadcast receiver again to 610 kilocycles. Since the tube is oscillating, it is grinding out many other frequencies as well, some of them very high. For example, the tenth harmonic will be 49.2 (approximate) meters or 6100 kilocycles. Suppose we have a short-wave receiver operating on the 40-meter band. It will probably receive the 49.2-meter harmonic from our broadcast receiver. Here then is a point for our short-wave receiver calibration. Other points may be obtained in the same manner. The receivers (short-wave and broadcast) may be coupled loosely by winding a turn around each inductance and connecting them together.

Let us, however, try another scheme. Suppose we tune our short-wave receiver so that a beat note is heard when the broadcast tube is oscillating at 610 kilocycles. This means that some harmonic of 610 kilocycles is beating with either the fundamental, or a harmonic, of our short-wave tube. It is probably the fundamental, and at any rate the following routine will determine exactly what wavelength it is.

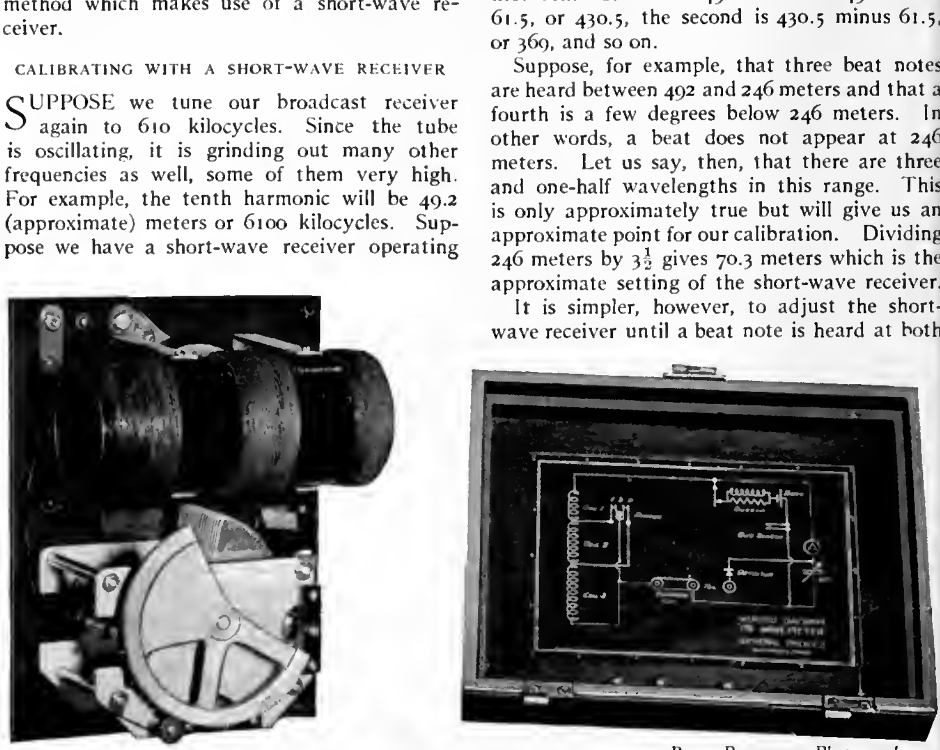
Let us listen in the "blooper" receiver, accurately set it at 610 kilocycles, and tune the heterodyne wavemeter until a beat note is heard—without changing the short-wave set, of course. The heterodyne oscillator is now tuned to 610 kilocycles. Now we can listen in the short-wave set and it will be found that other beat notes will be heard if the heterodyne meter is varied from 610 kilocycles to some other value, and a particularly strong note will be heard when the meter is tuned to 246 meters or 1220 kilocycles, the second harmonic of 610 kilocycles.

Now between 492 meters and 246 meters there is a difference of 246 meters. And supposing for example, that as we tuned the heterodyne wavemeter we heard four beat notes between these two wavelengths, we may say that four times between 492 and 246 meters, a total difference in wave length of 246 meters, we have tuned to some frequency which has a harmonic that beats with the fundamental of our short-wave set. This fundamental will, naturally, be 246 divided by 4, or 61.5 meters, which is the setting of the short-wave receiver, and the points on the heterodyne meter which cause beat notes will be 61.5 meters apart. This means that the first beat note below 492 meters is 492 minus 61.5, or 430.5, the second is 430.5 minus 61.5, or 369, and so on.

Suppose, for example, that three beat notes are heard between 492 and 246 meters and that a fourth is a few degrees below 246 meters. In other words, a beat does not appear at 246 meters. Let us say, then, that there are three and one-half wavelengths in this range. This is only approximately true but will give us an approximate point for our calibration. Dividing 246 meters by $3\frac{1}{2}$ gives 70.3 meters which is the approximate setting of the short-wave receiver.

It is simpler, however, to adjust the short-wave receiver until a beat note is heard at both the fundamental and second harmonic of 610 kilocycles—or whatever the original frequency happens to be. This method will give us several points on the 60-turn coil of our heterodyne meter.

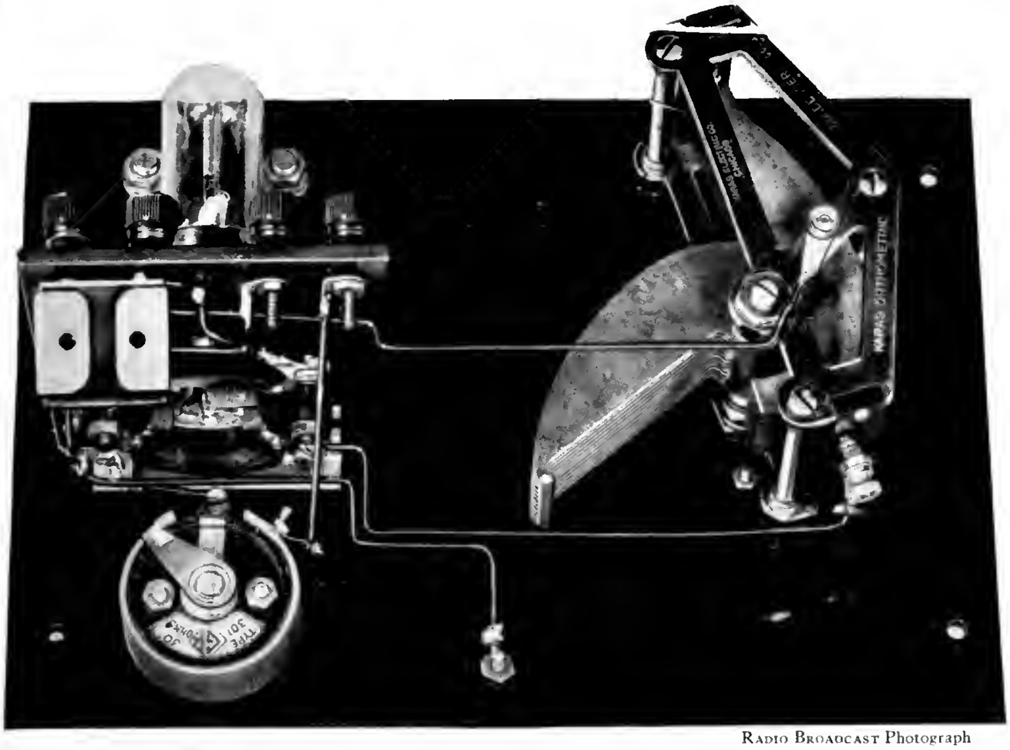
Setting the short-wave receiver at some definitely known wavelength, obtained by the above method, we may use a smaller coil in the heterodyne wavemeter and tune it until a beat note is again heard in the receiver. This will indicate



Radio Broadcast Photograph

FIG. 13

This is an interior view of a buzzer type wavemeter which is a product of the General Radio Company. It has a range of 2000 to 100 kilocycles (150 to 3000 meters). Note the rugged construction of the coils



RADIO BROADCAST Photograph

FIG. 14

The interior of the RADIO BROADCAST Laboratory heterodyne wavemeter. Note the rigid construction, the short leads, and the accessibility of all parts

that the heterodyne meter and the short-wave receiver are tuned to the same frequency.

In this manner, with a single accurately known frequency, a set of coils for the heterodyne meter, and a short-wave receiver, we may completely calibrate the wavemeter as well as the short-wave receiver.

There are several precautions that must be taken when one calibrates a wavemeter or a receiving set by means of harmonics. In the first place, one must know definitely what harmonic he is beating with, for if a single harmonic is missed the calibration will be out. If too close coupling is used between the source of oscillations and the receiver, fractional harmonics will be heard which are difficult to estimate in wavelengths. For example, it is possible that the second harmonic of one frequency will beat with the third of another instead of with the fundamental.

The following method of taking data will aid in avoiding difficulty of this nature. Suppose again that our heterodyne oscillator is set at 610 kilocycles, and that we tune the short-wave receiver until a beat note is heard. Some harmonic of 610 kilocycles is then beating with the fundamental of the short-wave set. Now vary the condenser of the heterodyne meter and note each point that a new beat note is heard. If we are picking up the beat between the correct harmonics there will be approximately the same number of condenser degrees between each beat note.

For example, on our Laboratory oscillator, 610 kilocycles is found at 60 degrees on the tuning condenser. Beats are obtained when the condenser is tuned as follows:

91 74½ 60 47 36 26½ 18 10¾

Subtracting each one of these figures from the preceding one we obtain

16½ 14½ 13 11 9½ 8½ 7¼

And subtracting again we obtain

2 1½ 2 1½ 1 1¼

These differences are perfectly regular, showing that we have not missed any harmonics on our path from 610 kilocycles to the second harmonic of 610 or 1220, and beyond. The line of reasoning then is as follows: Between 60 and 18 degrees were four beat notes which are caused by different broadcast frequencies, each of which has a harmonic whose wavelength is equal to that to which the short-wave receiver is set. The difference between 610 and 1220 kilocycles is 246 meters, which, divided by four makes 61.5, the setting of the receiver.

BUREAU OF STANDARDS SIGNALS

IN CONNECTION with calibration problems, the short-wave transmissions of several Radio Corporation stations are important, and their frequencies may be found by consulting one of the tables of short-wave stations mentioned in the bibliography. Standard frequencies are transmitted from WWV, Bureau of Standards, Washington, District of Columbia, from 6XBM at Leland Stanford, Jr. University, and 1XM, Massachusetts Institute of Technology (short waves only). Methods of receiving and interpreting these signals from WWV may be obtained from the Bureau of Standards *Letter Circular 171*.

For the home laboratory, the first meter should be a simple coil-condenser affair calibrated by means of broadcasting stations. The next meter should probably be a heterodyne meter which may be equipped with a WD-12 tube and a grid milliammeter, which will cost about $15, but which in general usefulness surpasses many other expensive instruments. A plate 0-5 milliammeter lists at about $8.

It is sometimes useful to shunt the tuning condenser across a small part of the coil so that greater accuracy may be obtained. In this case the full scale of a 180-degree condenser may be made to cover but a few kilocycles instead of several hundred.

Future articles in this series for home experimenters will show more of the uses to which the modulated oscillator and the heterodyne wavemeter may be put.

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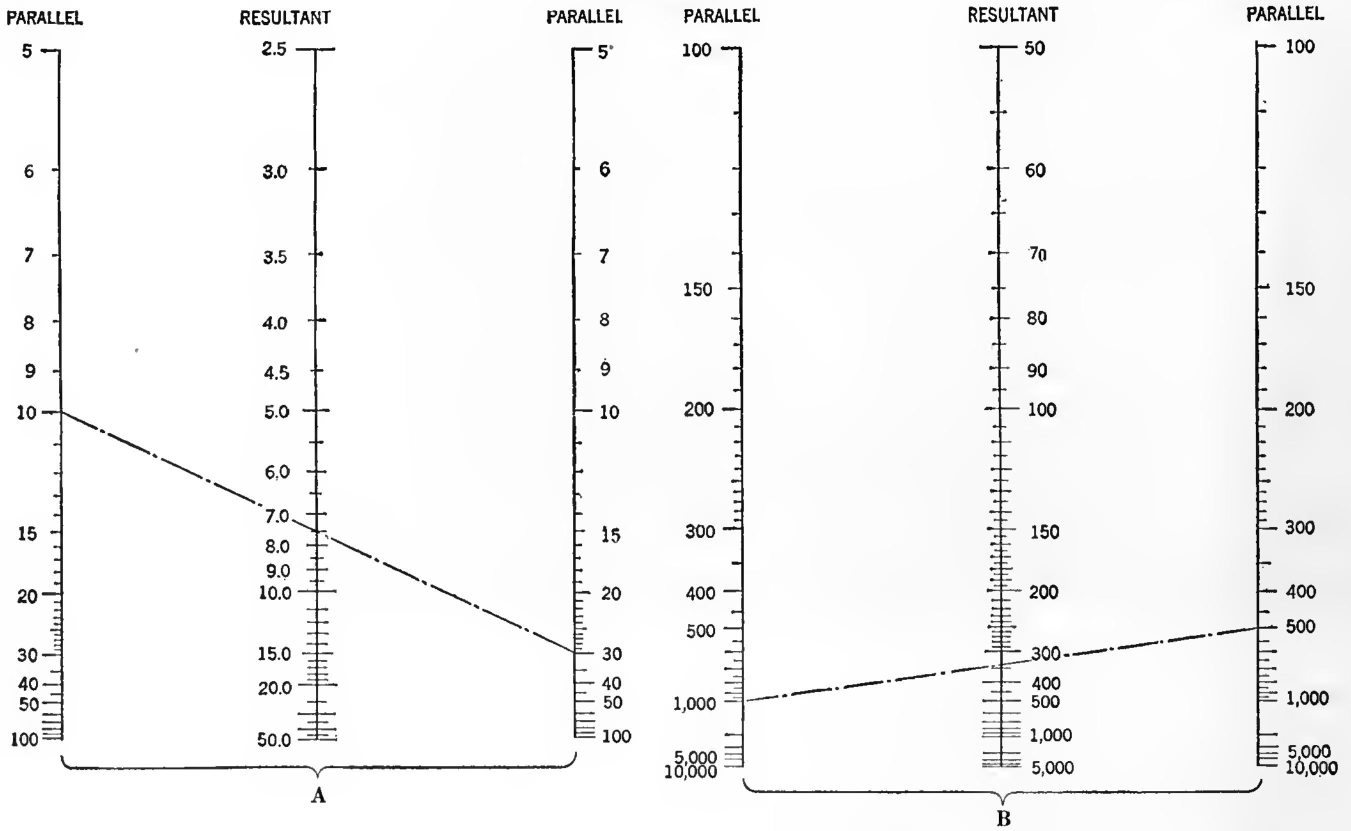
RADIO BROADCAST Photograph

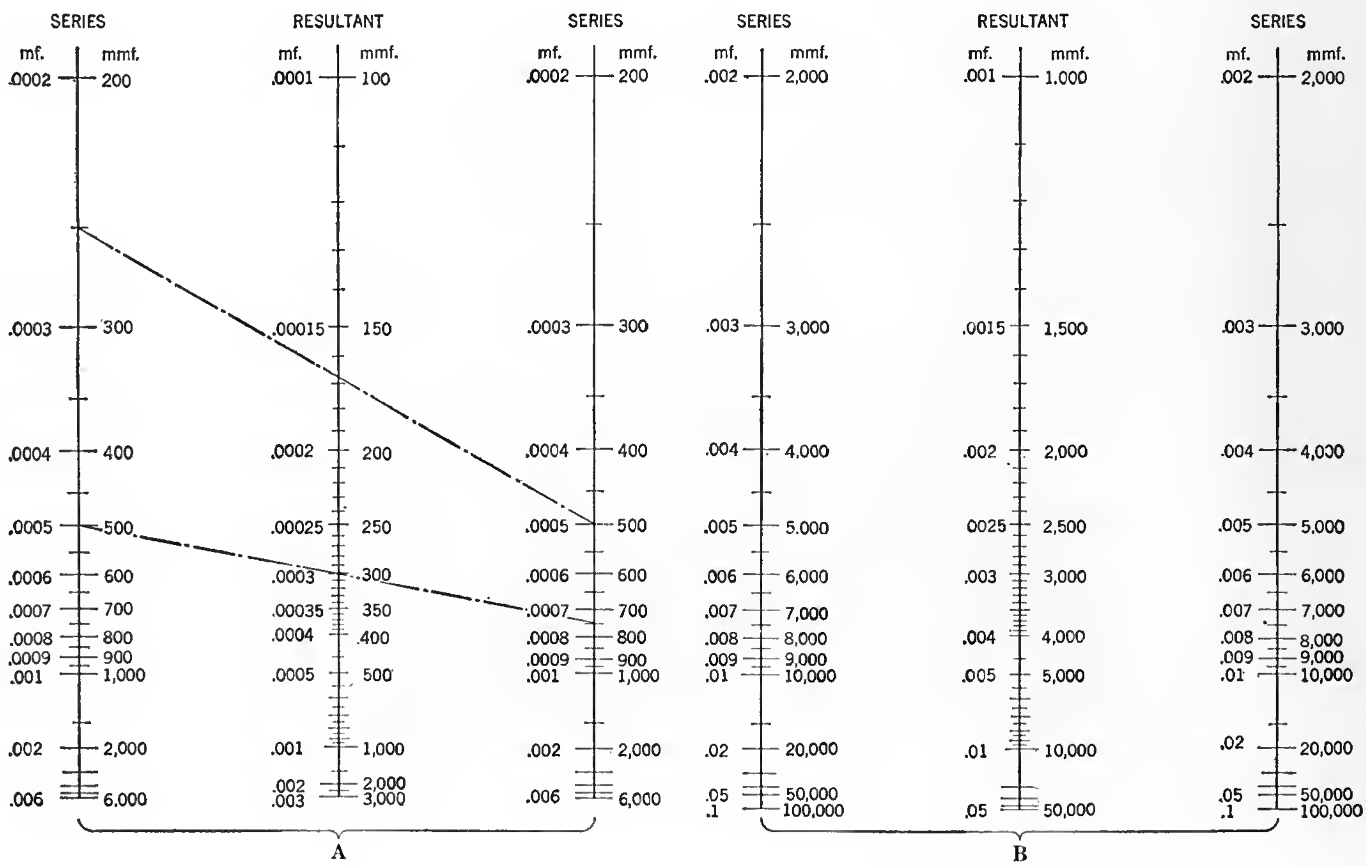
FIG. 15

With the aid of the oscillator shown in this photograph, the characteristics of various coils may be determined before they are included in a wavemeter

RESISTANCES IN PARALLEL
(in Ohms)



CAPACITIES IN SERIES



Removing Mathematics from Resistance and Capacity Calculations

How Your Filament Rheostat's Value May Be Altered to Accommodate New Tubes—Combining Fixed and Variable Condensers to Give a Required Capacity—The Range of the Accompanying Charts May Be Extended

By HOMER S. DAVIS

RESISTANCES

ALIGNMENT or calculation charts have long been in use among engineers for the easy solution of mathematical formulas. By their means, difficult calculations are avoided. The drawing of one or two straight lines with a pencil and a ruler is the only effort necessary to arrive at an answer when such charts are utilized, and that answer is more likely to be correct since the possibility of numerical errors is eliminated. A knowledge of advanced mathematics is not at all necessary. In the March, 1926, number of RADIO BROADCAST, such a chart was presented by means of which the reader was enabled to design a single-layer inductance coil to cover a given frequency range with a given size of tuning condenser. A wavelength-frequency conversion chart appeared in the February, 1926, RADIO BROADCAST. In the present article, charts have been further applied to the solution of resistances in parallel and of capacities in series. Additional charts dealing with other problems in the design of radio apparatus and receivers are now in preparation. It is suggested that the reader preserve these charts for future reference.

When resistance units, such as rheostats, grid leaks, coupling resistors, are connected together in series, the resultant resistance of the combination is the sum of the individual values. Thus, if a rheostat or grid leak is found to be too small, and the correct size not available, the required additional resistance may be connected in series with it. But when they are connected in parallel, or shunt, an entirely different relation holds. The resultant resistance is then less than that of any one component, and in the case of only two resistances, is given by the formula:

$$R = \frac{r_1 r_2}{r_1 + r_2}$$

when R = the resultant resistance and r_1 r_2, the resistances in parallel. By virtue of this property, a resistor may be reduced in value by shunting it with another.

Two charts are presented for resistances in parallel, based on the above formula, the first, A, covering the range of 5 to 100 ohms, the second, B, 100 to 10,000 ohms. Their correct use is best illustrated by working out one or two examples. Suppose that two rheostats, one of 30 ohms, the other 10 ohms, are at hand, and it is desired to know their resultant resistance when connected in parallel. Draw a straight line between 10 on one outside scale of Chart A, and 30 on the other outside scale; the point where this line cuts the center scale marks the value of the resultant resistance, 7.5 ohms in this case.

To find the resistance necessary to shunt across an existing resistance to bring it down to any desired size, draw a line from the known value on an outside scale to the desired resultant value on the center scale, and continue the line to intersect the other outside scale, reading the answer at this point. The range of either of these two charts may be extended by considering the values on each of the three scales as multiplied by some constant. For instance, if the values on Chart B are multiplied by 1000, the range then will be from 100,000 to 10,000,000 ohms, or 0.1 to 10 megohms. To take an example, the resultant resistance of a 500,000-ohm (0.5 megohms) and a 1,000,000-ohm (1.0 megohm) resistor in parallel may be found by drawing a line between 500 and 1000 on the outside scales, the intersection with the center scale at 330 giving the answer as 330,000 ohms (0.33 megohm). In extending the range of a chart in this way, the reader should be careful to use the same multiplier on all three scales.

Resistance units are coming into more extensive use every day, some of the more recent applications being as coupling resistors, stabilizers for radio-frequency amplifiers, regeneration controls, volume regulators in audio-frequency amplifiers, and voltage regulators for battery eliminators. A knowledge of how to combine them to obtain different values of resistance should be of value to the constructor in avoiding delays and affecting savings in his outlay of parts.

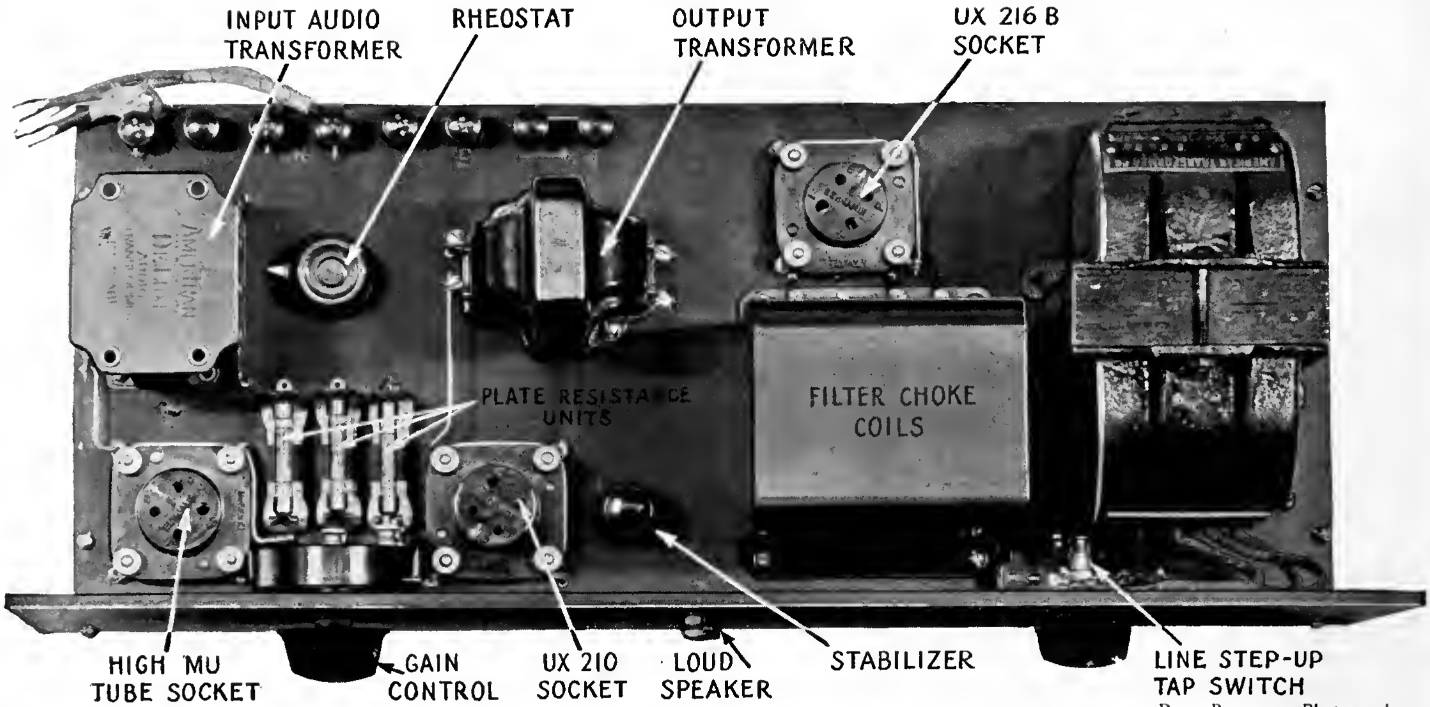
CONDENSERS

CONDENSERS may also be connected in series or in parallel to obtain any desired value of capacity, but here the case is reversed from that of resistance units. That is, if two or more condensers are in parallel, their capacities are added to obtain the resultant; but if they are connected in series, the resultant capacity is then less than that of any one of them, and in the case of only two condensers, is given by the formula:

$$C = \frac{c_1 c_2}{c_1 + c_2}$$

where C is the resultant capacity, and c_1 c_2, etc., the various capacities in series.

Charts for this formula are presented, again in two ranges. Values in microfarads and in micromicrofarads have been plotted on opposite sides of the scales. To work out an example illustrating their use, suppose that a radio-frequency transformer is to be used which requires a 0.0003-mfd. tuning condenser to cover the broadcast band of frequencies, and that a 0.0005-mfd. condenser is the only one at hand. To use this condenser would be undesirable, since it would crowd the tuning toward the lower end of the scale, and a considerable portion of the upper end would be unusable. This may be remedied by connecting a high grade mica fixed condenser in series with the tuning condenser to bring its maximum capacity down to 0.0003 mfd. The size of the fixed condenser may be found with the calculation chart by drawing a straight line from 0.0005 on an outside scale through 0.0003 on the center, or "resultant," scale, and extending it to meet the other outside scale; this point indicates 0.00075 as the required size of the fixed condenser. If this size is not available commercially, it may be made up by connecting together a 0.00025- and a 0.0005-mfd. condenser in parallel. To take another example, it is desired to know the resultant capacity of a 0.00025- and a 0.0005-mfd. condenser in series. Connect these values on the outside scales and read the answer, 0.000168 mfd., at the intersection with the middle scale. The ranges of these charts may be extended by the use of a suitable multiplier as was done with the resistance charts.



RADIO BROADCAST Photograph

A Quality Amplifier—Power Supply

Description and Constructional Details of an Amplifier Operating from the 110-Volt Mains Which Delivers Sufficient Plate Potential for Use with the New Tubes

By ARTHUR H. LYNCH

WHAT constitutes a good audio amplifier system? This question has been argued pro and con, among radio dealers, in the pages of radio publications, at engineering societies—everywhere. Even among the engineers who are engaged in research and experiments to investigate the field of audio frequencies, this subject is a very prominent bone of contention.

To classify the audio amplifier systems is not difficult and each particular one has very definite qualifications which make it a favorite. Those who desire great volume and fairly good quality find the transformer style of audio amplifier entirely satisfactory. Others are more interested in the resistance and impedance systems of audio amplification. It is not the purpose of this paper to continue the argument but rather to describe a type of amplifier which, while not new or revolutionary, combines some very distinctive and worth while features that go toward making up a complete unit satisfactory to the *n*th degree.

As early as September, 1925, the trend toward better and better audio amplification started when George C. Crom, in a paper, "Some Remarks on Better Audio Amplification" in the October, 1925, RADIO BROADCAST, outlined the general requirements for an audio amplifier system that would not outrageously distort the signals introduced to an amplifier.

The slight trend has gradually become a landslide as evidenced in the many new contributions from radio manufacturers in the form of high quality audio frequency transformers, power tubes, semi-power tubes, choke coils, and resistance units for amplifiers. All these insure, on the part of the constructor, something better in results than before. The trend is unmistakably manifest, too, in the new designs of complete power amplifiers which have been placed on the market such as the Pacent Power-former and Radio Corporation Uni-Rectron.

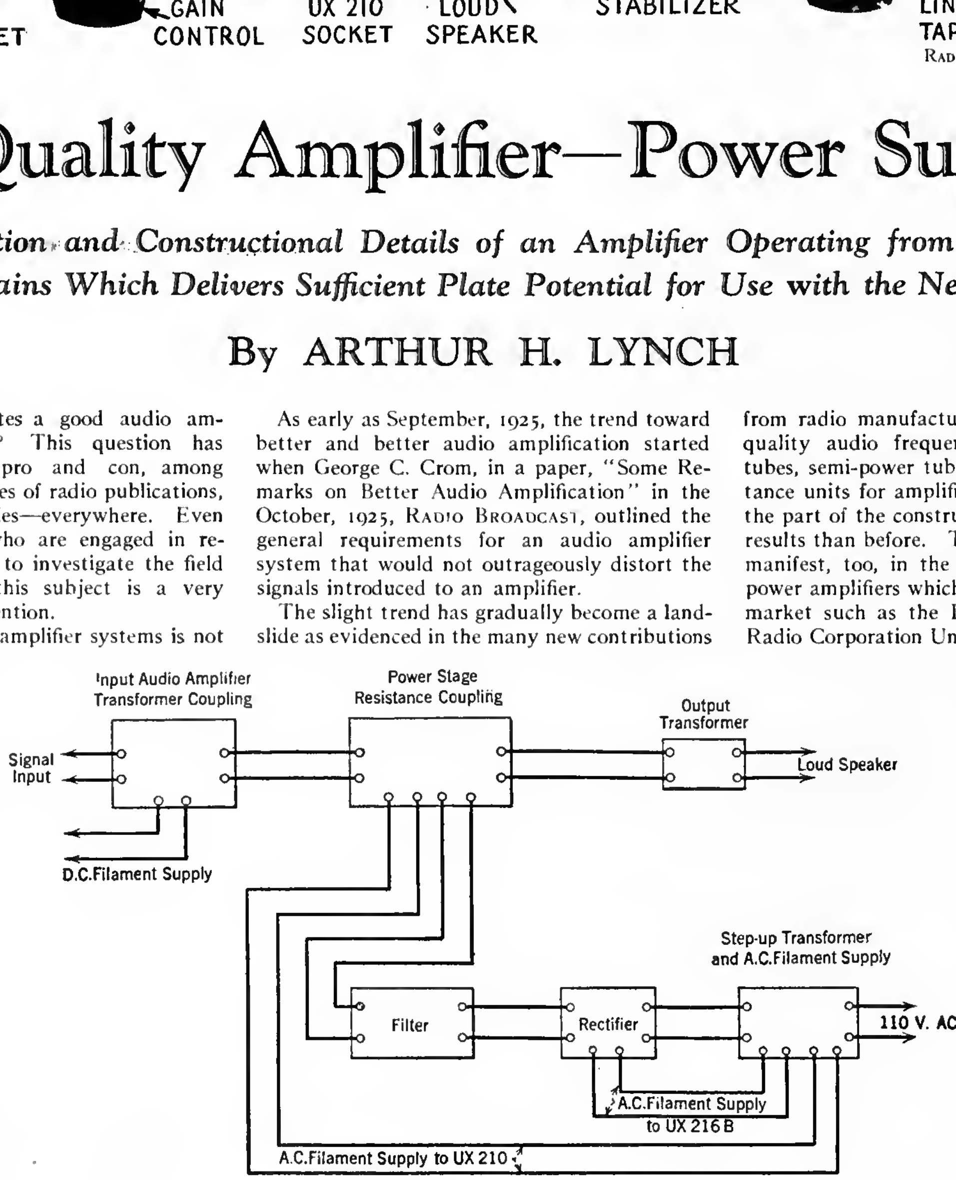


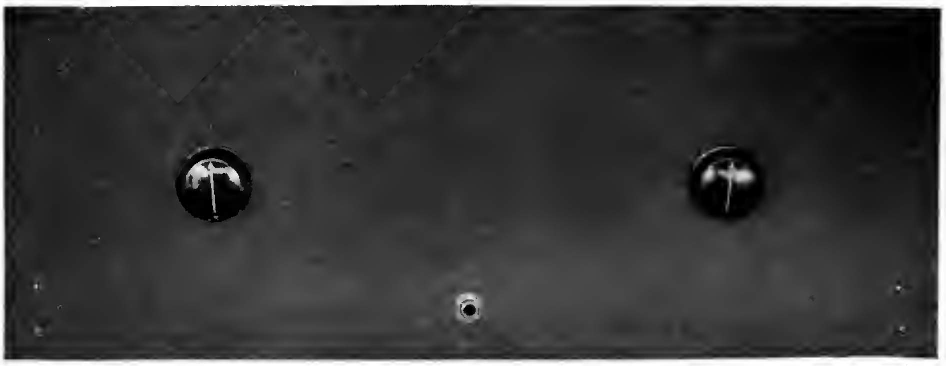
FIG. 1

The power amplifier consists of several major units which in turn consist in some instances of lesser units. Then, too, there are several lesser connecting links. This is made clear above where the three major units are 1—*input amplifier*, 2—*power stage*, 3—*power supply*. The power supply itself is made up of three units, namely the step-up transformer, rectifier, and filter

As one answer to the question that forms the first sentence of this paper, the description of the construction of a combined power stage and plate supply device, employing high grade parts easily obtainable, is offered. Much is due to James Millen and Frank M. Squire for their collaboration and contributions to the design of the device described here.

The diagram, Fig. 1, shows simply the system described in this article.

The test of a good amplifier is summed up in its ability to reproduce faithfully and magnify the signal as it is passed out of



Radio Broadcast Photograph

FIG. 2

Two controls and an output jack mounted on the panel are the only visible parts of power supply

the detector of a receiver. This necessitates the use of high quality transformers that are designed to work in the particular stage in which they are used; that are designed with cores large enough to prevent saturation effects and other requirements that, in the new designs, have been met. The constructor can select his parts with a bit of reason and the assurance that the completed job will produce good results.

Where the coupling medium between tubes is to be resistance units, there are other requirements that must be met. These resistances must not deteriorate—at least not too quickly; they must be so used and constructed as to enable one to pass a high current through them and have the generated heat dissipated without injury to the resistance unit or causing a change in its resistance.

The power supply must be noiseless in operation and should be capable of supplying an output voltage sufficient to apply to the plate of the tube in the power amplifier, such as the UX-210 or other power tube.

PLENTY OF VOLTAGE FOR THE AUDIO STAGES

THE power amplifier illustrated and described here was built to provide a model fulfilling these requirements and to provide additional refinements evident from the description and illustrations. This high quality power amplifier device is designed to operate from the detector of a regular receiver.

The input unit of the power amplifier is one of the new AmerTran transformers to whose primary terminals is connected the output of the detector. The transformer secondary terminals lead to a high-mu tube whose output is coupled by resistance coupling to the power tube, the UX-210. Three 100,000-ohm units are connected in series for the plate circuit and a 500,000- and 50,000-ohm resistor are inserted in the grid return circuit. The 50,000-ohm unit is a standard Centralab variable resistor which to a large degree controls the volume of the power amplifier.

The loud speaker connections do not come directly from the plate of the power tube because the applied voltage is on the order of some 400 or 500 volts. The effects produced when one comes in contact with the live side of the power supply are not over-pleasant and might result in some injury. To avoid that danger, an output transformer arrangement effectively isolates the loud speaker terminals from the high voltage supply, yet preserves the quality of the output because the impedance of the loud speaker may be more accurately matched with the impedance of the secondary coil of the output transformer.

The voltage supply, perhaps, is most difficult of all the units to construct, but with a bit of care and patience a very good looking job of correct electrical design may be approximated by the individual constructor.

The constructional features outlined above are clearly depicted in the circuit diagram for the amplifier shown in Fig. 3. Here also may be seen the arrangement of the voltage supply unit. An AmerTran step-up transformer, having a 3-step variable primary and a secondary 500-volt output is rectified by the R C A 216-B rectifier tube. After rectification, the transformer output is filtered to minimize the pulsations caused by rectification so that as little hum as possible is passed along to the loud speaker. In the construction described here no hum could be heard on the sensitive Western Electric 540-AW cone. The filter unit is a General Radio type 366 consisting of two 30-henry choke coils to which are externally connected three 2-mfd high voltage Tobe Deutschmann condensers arranged as shown in the circuit. The ordinary run of bypass condensers will not consistently stand up when included in the filter part of a power supply circuit, and for this reason it is well to obtain condensers designed for the purpose and which have been tested for 750 or 1000 volts breakdown. If a larger size of filter condenser, such as 6- or 8-mfd, is procurable it is exceedingly advisable to place it in the filter circuit to take the place of the 2-mfd. condenser shown at the extreme left end of the filter circuit in the diagram, Fig. 3.

Besides furnishing the high voltage for the plate circuit of the two amplifier tubes, the line transformer is provided with two additional

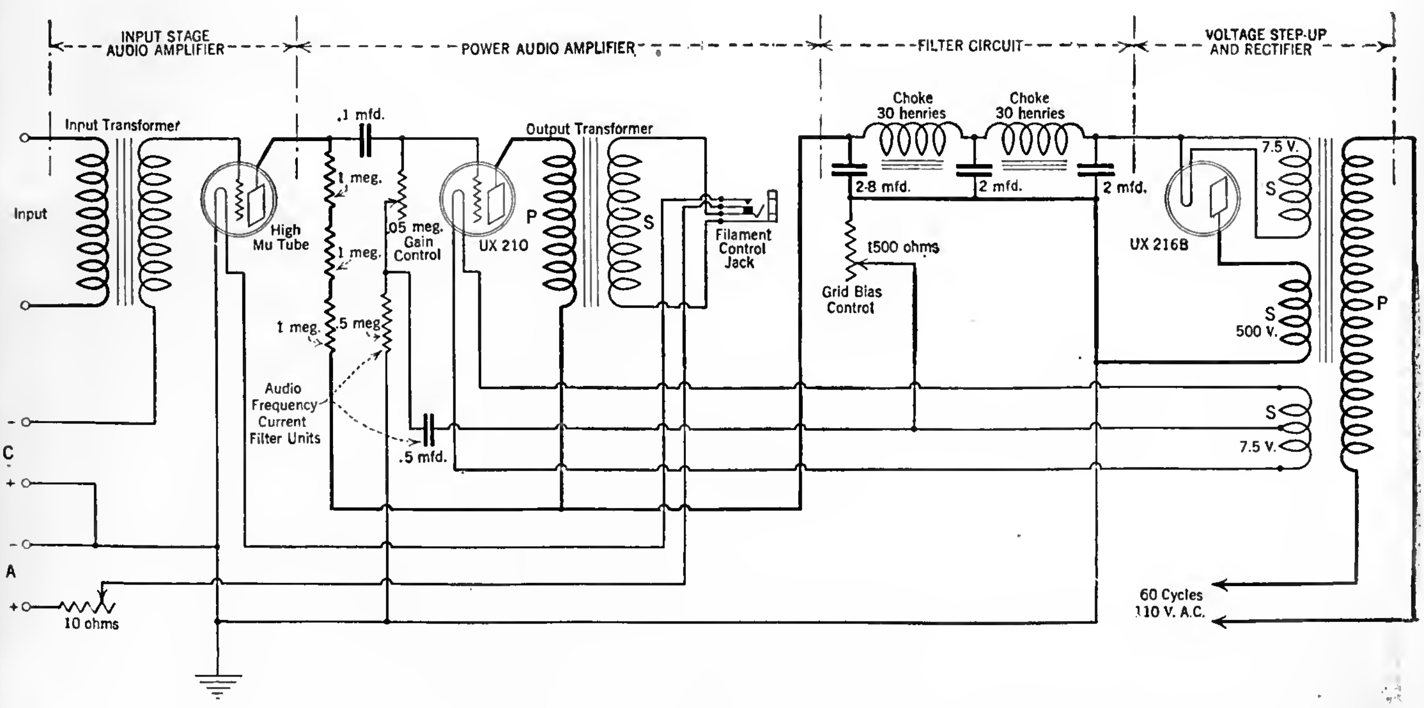


FIG. 3

This is the complete circuit diagram of the power amplifier. The path of the signal, as it is amplified, is from left to right until it passes out into the loud speaker. The path of the voltage supply begins at the right, is stepped-up, rectified, filtered and then delivered to the amplifier tubes. Of importance is the fact that the filter condensers should be capable of withstanding 1000 volts d.c. flash test. If a line transformer such as the AmerTran is used a line top switch may be included to vary the step-up ratio of the transformer. This switch is shown at the right of illustration Fig. 2.

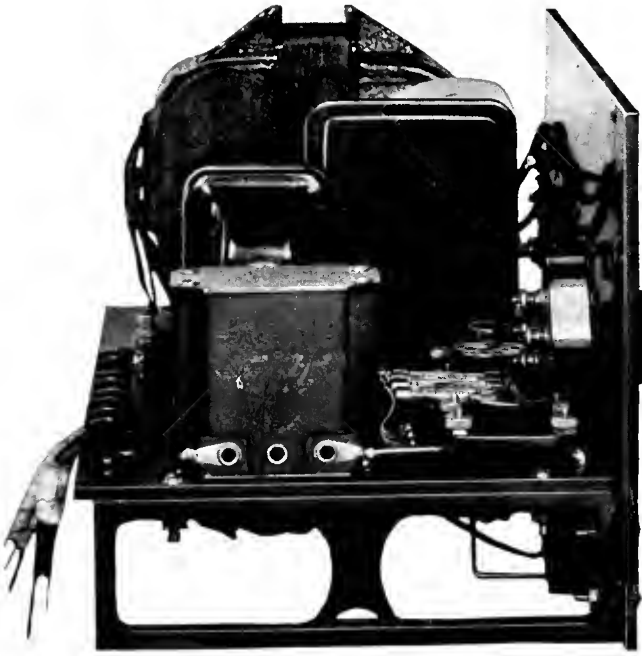


FIG. 5

From this right side view of the power supply unit may be observed the alignment of the various transformers and sockets, etc., on the sub-panel. The layout closely follows the order of signal and voltage paths as described in the caption for Fig. 2

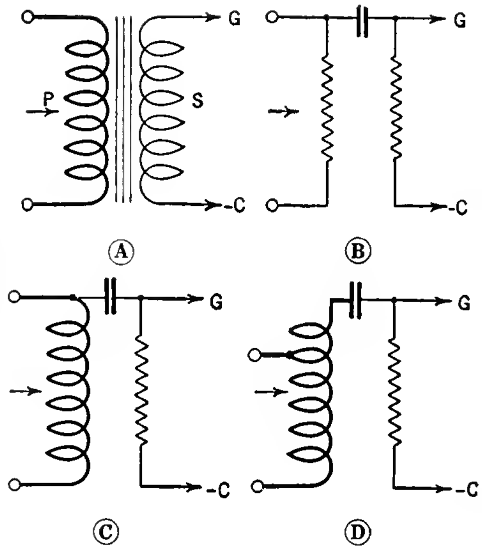
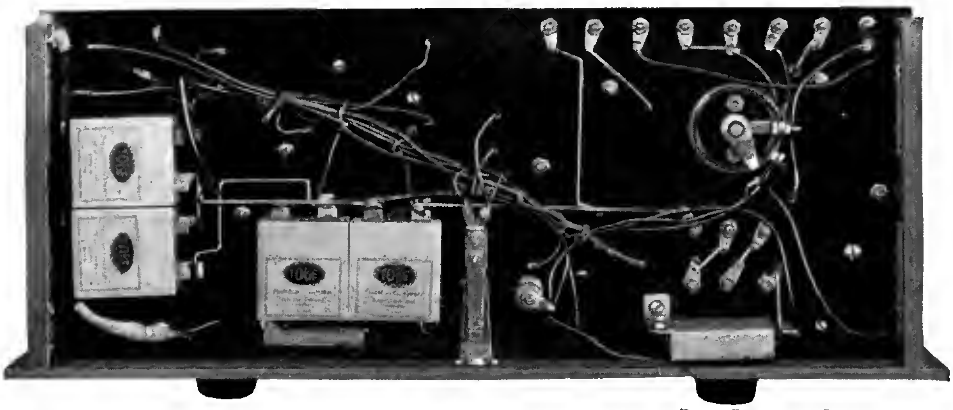


FIG. 4

Here are various methods of coupling that may be employed as the system input in this amplifier, between it and the receiver. A is a transformer, B resistance coupling, C impedance, and D autotransformer impedance coupling

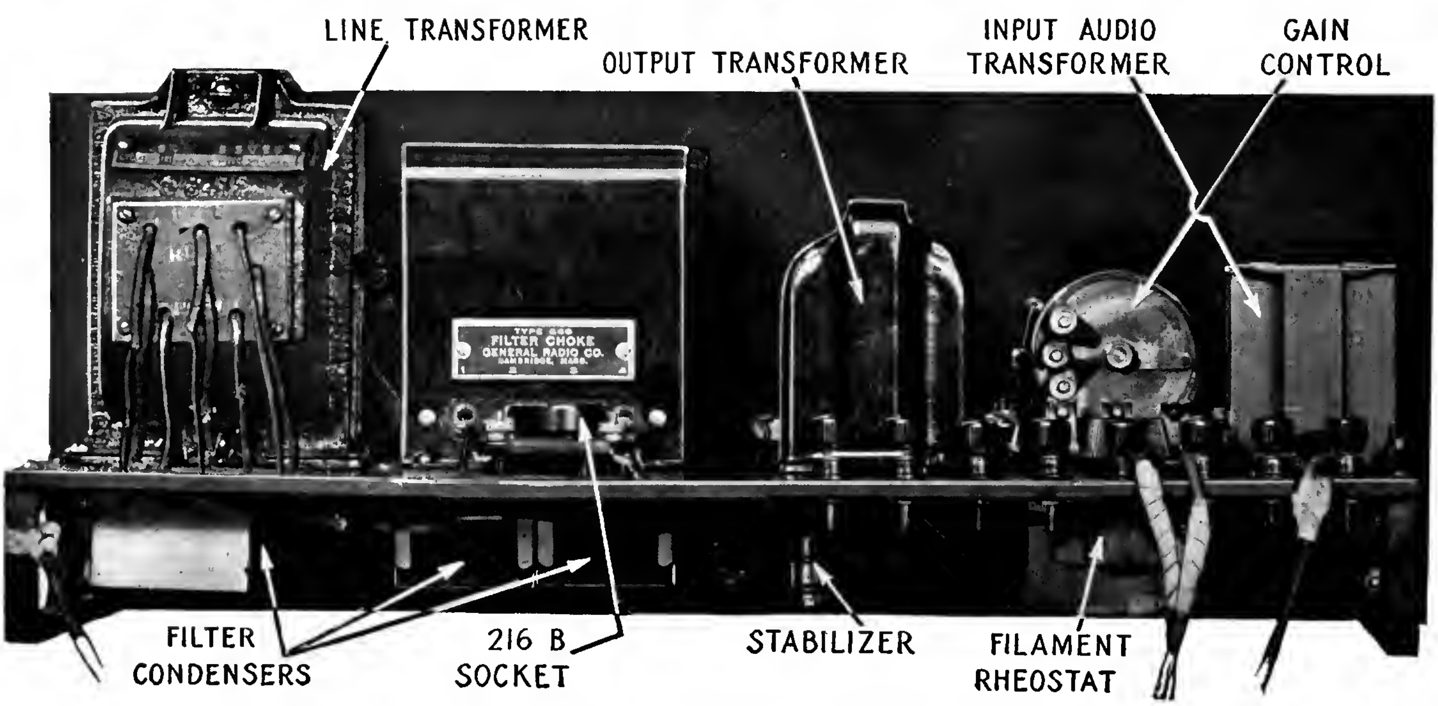
windings capable of supplying 7.5 volts each, for lighting the filaments of the UX-210 and the 216-B. Of course, it is possible to light the filament of the high-mu tube from a.c. That involves a complication in construction with the probability that a noticeable hum will be evident in the loud speaker. This has not been made a part of the present layout and here the filament is energized from the A battery. By means of a filament circuit jack in the output of the amplifier, the high-mu tube filament is turned on when the plug is inserted and turned off when removed. By removing the plug of the cord attached to the primary of the line transformer from the base outlet or lamp socket, the high voltage and filament voltage is simultaneously removed from the rectifier and power amplifier tubes. The



Radio Broadcast Photographs

FIG. 6

As may be observed from the photograph to the left and the others accompanying, a major portion of the wiring is located underneath the sub-panel, presenting a clean non-complicated appearance of "the works" situated on the top of the panel. Below is a self-explanatory rear view of the unit



new Brach switch can well be used for this purpose.

PARTS WHICH CAN BE USED

ALL the parts used in the experimental model described here are readily obtainable. For those who desire to duplicate the construction shown here, the following list of parts is given first, and several alternative makes of parts are also listed.

Line transformer
AmerTran, Dongan, General Radio, Thordarson
Sockets
Benjamin, Cutler Hammer, Eby, Pacent
Audio transformer
AmerTran, Pacent, Jefferson, Rauland Lyric
Resistance coupling unit
Lynch, Dubilier, Durham,
Grid Control
Centralab, Royalty Clarostat
By-pass and filter condensers
Tobe Deutschmann, Dubilier, Sangamo, Mayo, American Electric
Filament Jack
Carter, Yaxley, Pacent
Filter Chokes
AmerTran, General Radio, Dongan Thordarson
Binding Posts
Eby, Fahnestock
Sub Panel Brackets
Radion, Cardwell, Benjamin
Filament Rheostat
General Radio, Carter, Yaxley, Centralab
Output Transformer
General Radio

There are many ways in which the individual constructor may mount all this material, and the photographs accompanying will suggest several possibilities. It is well to employ a construction where a sub-panel is included so that most of the smaller type of apparatus, such as by-pass and filter condensers, resistance units, rheostats, etc., may be mounted underneath it. Up on top of the sub-panel may be located the tube sockets, line transformer, audio transformer, resistance-couplers, output transformer and filter choke coils. On the main panel which should be higher than 7 inches, to prevent the tube from projecting above the top, the volume control, line top switch and output jack are situated.

It is absolutely essential in wiring the amplifier that rubber covered or other good insulated wire be used. If possible, all exposed terminals should be well taped so as to reduce the possibility of body contact with the high voltage output. By referring to the illustration, it is possible to approximate the layout of the model which, since its first moment of use, has given admirable results.

In a future issue will be given the actual specifications and directions for building a power amplifier unit that meets with the most drastic regulations set up for this type of device by the National Board of Fire Underwriters.

The model described here serves well indeed for experimental purposes where it is desired to use the same power supply as a complete plate voltage supply unit.

OPERATING NOTES

IN OPERATING the power amplifier it will be noticed, if a 50 mil milliammeter is placed in the plate circuit of the UX-210, that a slight fluctuation of the meter needle occurs when receiving strong signals, denoting some distortion. This distortion can be cleared up by adjusting the variable grid bias control until the needle remains constant in its deflection.

To prevent audio frequency currents from going through this grid bias control, a special filter circuit is provided consisting of the 0.5-meg. resistance unit and 0.5-mfd. condenser. The resistance offers enough impedance to the flow of audio frequency currents so that the only path available is through the 0.5-mfd. condenser. An average plate current for the UX-210 is 25 milliamperes, and if this reading is less even when the grid bias control is at a minimum resistance value, this shows that one or more of the filter condensers is defective. Another indication of a broken down or leaky condenser is in the overheating of the rectifier tube.

ALTERNATIVE INPUT COUPLING METHODS

THE input to the power, or current-amplifier tube, is through a rather unique resistance coupling device, which serves the dual purpose of feeding the output of the first or voltage amplifier stage into the grid circuit of the power tube and also reduces the high voltage from the filter system to approximately 150 volts, which is suitable for impressing on the plate of the first amplifier tube, which may be of the ordinary 201-A type, or one of the high-mu tubes.

The reason for using the three 0.1-megohm resistors in series, instead of a single unit with a resistance of 0.3 megohms, is that the latter would not carry the current without heating. This would vary the resistance as the temperature varied. As a matter of fact, where ordinary fixed resistors are used for this purpose, their resistance should be checked from time to time. A simple method of checking this resistance is to measure the voltage impressed on the plate of the first amplifier tube. Obviously, if the resistance of the units varies, the voltage on the plate will vary also. Except for these points, there is nothing novel about the resistance coupled stage, save that it has been found very satisfactory to use a high-mu tube for the first stage or voltage amplifier.

There may be some discussion concerning the most advisable system of coupling the first stage to the detector tube. Four kinds of coupling indicated in Fig. 4, A, B, C, and D were tried. The best results for general use were obtained from the system shown in A, Fig. 4, where the transformer is one of the new AmerTran De Luxe Type and the tube, one having an amplification constant of approximately 20. Other transformers were tried and satisfactory results were obtained from a number of them, but the AmerTran showed up best.

The systems shown in Fig. 4, C and D, being National Impedaformer and Thordarson Autoformer coupling, respectively, were very satisfactory, from the standpoint of tone, but not capable of very great volume. Where impedance or autotransformer coupling was used, it was noted that a slight gain in volume was brought about by the use of a high-mu tube.

The best tone quality, but the poorest volume, was obtained from the resistance coupling arrangement, shown in B, Fig. 4. This system is not recommended for use where more than enough volume to fill an average size living room with dance volume is to be required. In fact, since the volume may well be controlled by the Centralab Modulator, in the grid circuit of the power tube, from a whisper to a roar, the use of a good transformer and high-mu tube combination is highly recommended and was found most satisfactory.

RADIO BROADCAST Photograph

FIG. 7

A bread board layout of an earlier experimental amplifier-supply unit constructed in RADIO BROADCAST Laboratory. One other unit was assembled employing other parts, such as Dongan line transformer and chokes. Potter condensers, Eby sockets, Jefferson Concertone audio transformer, etc., but space limitations prevent its being shown here

THE MODIFIED HAMMARLUND-ROBERTS

Has as its chief features a new method of regeneration control. In this article are given the fullest particulars for the necessary changes. A panel view of the revamped receiver, shown at the left denotes the location of the various parts employed in the change

Improving the Popular Hammarlund-Roberts Circuit

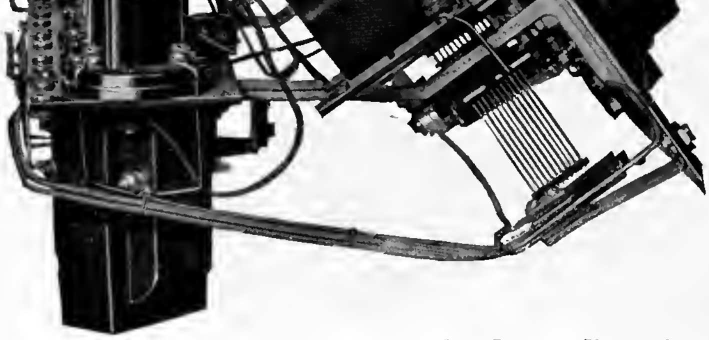
Easily-Made Changes Which Bring This Circuit Up to the Minute —How to Attain Smoother Regeneration Control—Using Power Tubes—How to Add Filament Control Jacks—The Final Circuit

By JOHN B. BRENNAN
Technical Editor, Radio Broadcast

IN REVIEWING the long line of circuits which have forged to the front in recent months, each one with its own special attributes claiming their due amount of attention, one cannot neglect considering the very popular Hammarlund-Roberts. Built up around the older famous Roberts reflex, it won immediate approval, and in its present form is satisfying its countless users. Yet, when one looks over this circuit, just as with others, there is the constant urge for improvement, revision, modification, and slight alterations to make it better.

Radio Broadcast Laboratory, in experimenting with the Hammarlund-Roberts version of the original Roberts circuit, has tried out numerous changes with the idea of improving the circuit. Some of the changes merely consisted in replacing the dials with ones of a vernier type while other changes were made in the actual circuit arrangement.

To begin at the beginning, it was found that the substitution of a different form of regeneration in the detector circuit, in place of the variable tickler method, would be worth while, in that control of regeneration itself would be smoother and also the changing field set up by variation of the tickler coil position would be eliminated. The method found to be most successful, and involving the least number of changes, was the condenser-feedback regeneration system, involving only the addition of a small variable condenser of the midget type and a radio frequency choke coil



Radio Broadcast Photograph

FIG. 1

By means of a Fahnestock clip attached to a flexible lead, the antenna turns may be connected in the circuit. Below is shown the filament circuit jack for head phones or reduced volume

ADDING A NEW FORM OF REGENERATION

IN MAKING this change, the entire detector coil unit is unsoldered from its connecting leads and removed from the panel. Then the tickler coil and its shaft are removed by simply cutting off that part of the bakelite strip which supports the shaft and its bearing. The bushing, located on the top of the bakelite mounting strip, is removed from the cut-off section and by means of a $\frac{3}{4}''$ x 6 machine screw is fastened at the bottom of the mounting strip. This screw replaces the one used to hold the coil between its insulated support strips. Now at that end of the secondary coil at which the NP coil is located, a tap is made thirteen turns from the bottom turn. These changes are evident from an inspection of the illustration, Fig. 2.

The detector coil may now be laid aside. A fifteen-plate Hammarlund midget condenser is mounted in the hole formerly taken up by the shaft of the tickler coil.

When this is accomplished, the detector coil

What the Charges Will Do

BEFORE	AFTER
CIRCUIT: One stage tuned neutralized radio frequency amplification, detector (with tickler regeneration), and two stages audio frequency amplification. The past stage employs a parallel tube arrangement.	CIRCUIT: One stage tuned neutralized radio frequency amplification, detector (with capacity feedback and r.f. choke coil), and two stages audio frequency amplification. The last audio stage employs a power tube.
TUBES: Five 201-A type.	TUBES: Three 201-A type. Last audio stage uses either UX-112 or UX-171.
VOLUME CONTROL: Rheostat control on r.f. tube filament.	VOLUME CONTROL: Variable high resistance shunted across the secondary of the first stage audio transformer.
FILAMENT CONTROL: Panel switch.	FILAMENT CONTROL: Filament jacks, one in plate circuit of first audio tube, and one in plate circuit of power stage.
PARTS DISCARDED	NEW PARTS REQUIRED
Filament switch, socket, open-circuit jack, rheostat, tickler coil, fixed 4-ohm resistance, bypass condenser.	Choke coil, 65-mmf. regeneration condenser, filament circuit jack (1st stage), filament circuit jack (2nd stage), volume control (variable resistance of 500,000 ohms).

to accomplish the desired result was to increase the value of resistance in the filament circuit of the radio-frequency amplifier tube or loosen up on the regeneration or sensitivity control. Quality sometimes suffered when the former method was employed. Selectivity and sensitivity suffered in the latter.

As a final refinement for volume adjustment, and also as a tone control, the rheostat and fixed resistance for the radio-frequency amplifier stage are removed. In the audio amplifier cir-

FIG. 2 Radio Broadcast Photograph

This is a "before and after" view of the Hammarlund detector coil unit. At the left is shown the coil before the alteration and at the right after the tickler has been removed. The bushing in the removed section is re-located at the lower end of the larger coil unit

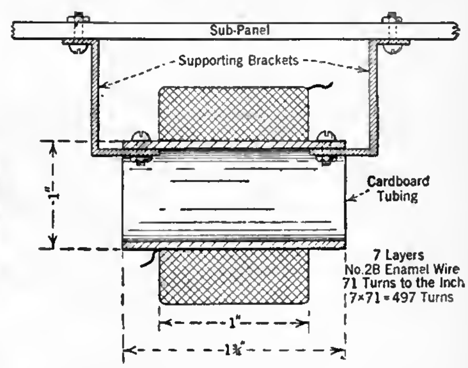


FIG. 3B

For those who wish to make their own r.f. choke coil, the specifications given in the above sketch will prove helpful

mounting holes are "spotted" on the main panel as illustrated in the sketch, Fig. 3A. These holes are drilled and countersunk for the $\frac{6}{32}$ machine screws which screw into the mounting bushings on the coil unit.

To obtain regeneration satisfactorily with these alterations it is necessary to in-

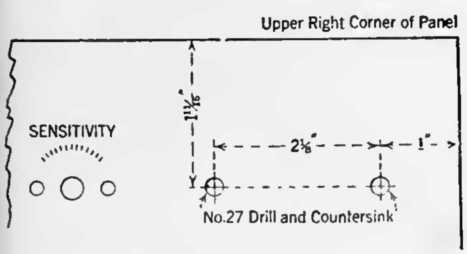


FIG. 3A

Two holes must be drilled in the panel to mount the detector coil. The layout is shown here

clude a choke coil in the audio transformer primary circuit. The one manufactured by Samson is entirely satisfactory. This choke is employed to keep the radio frequency currents out of the transformer primary circuit so that the only path for these currents to take is through the capacity element employed for regeneration. While not shown in the accompanying illustrations, this choke coil may be mounted on the sub-panel in the place left vacant by discarding one of the parallel audio stage sockets as is explained later. For those who desire to wind their own choke coil, the detailed specifications are shown in Fig. 3B. The connections for ther evised detector circuit are shown in Fig. 4. It will be noted that the bypass condenser employed to shunt the primary audio transformer has been eliminated from the circuit.

THE AUDIO CIRCUIT

MANY times it is found advisable to operate the receiver at reduced volume. In its original state, the only way cuit, their volume control functions are taken over by employing a variable high resistance of the value of 500,000 ohms in shunt across the secondary of the first audio transformer. This change is shown in the circuit sketch, Fig. 5. Much is gained by this revision, since the bad effects on tone quality, which are manifest in lowering filament voltage as was the practice in the circuit originally, are not present. Rather, the tone-quality is improved by the simple expedient of shunting a high value of resistance across

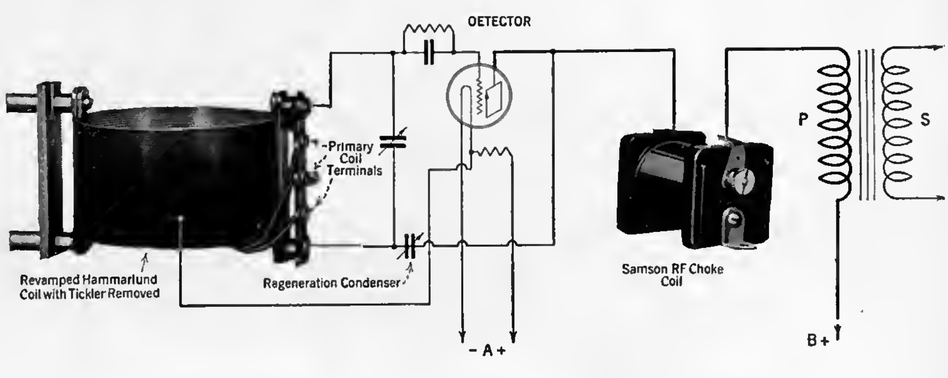


FIG. 4

A number of changes in the detector circuit make for very smooth regeneration control. A choke coil is necessary with the capacity feedback system employed to keep the r.f. currents from passing on through the primary of the audio transformer

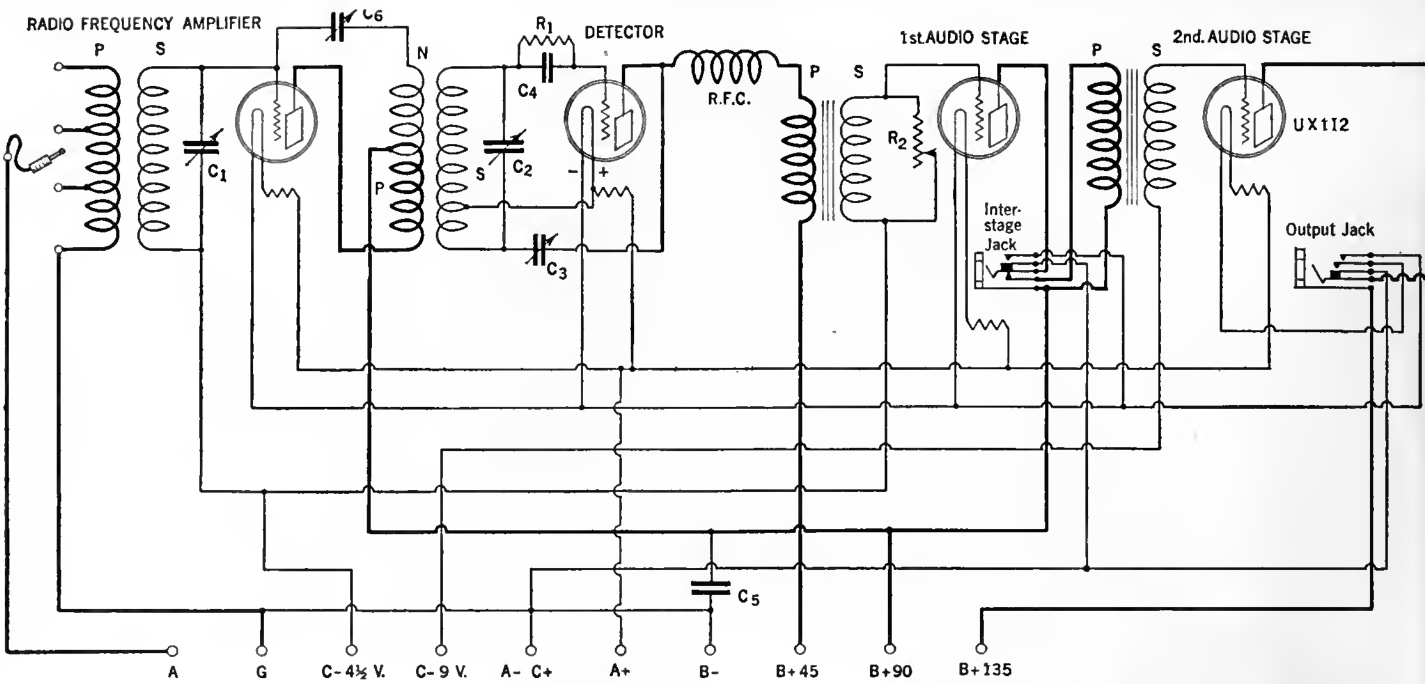


FIG. 5

All the changes in the circuit described in the text are shown in the diagram above. The values for the various parts are: C1 and C2, 0.0005 mfd; C3, 0.000065 mfd, a 15-plate midget condenser, C4, 0.00025 mfd; C5 0.006 mfd; C6, 0.000016 mfd; R1, 3-6 megs.; R2 is of 0-500,000 ohms

the transformer secondary, thereby aiding its response in more faithfully and equally reproducing sounds over a major portion of the audible scale. The object of this shunt resistance lies in its

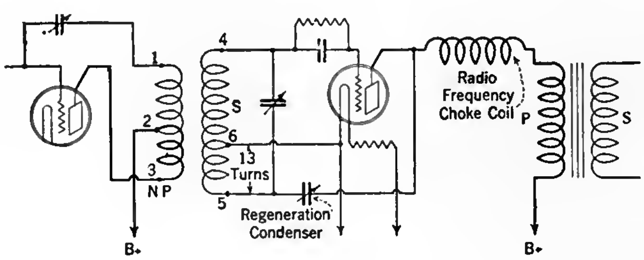


FIG. 6

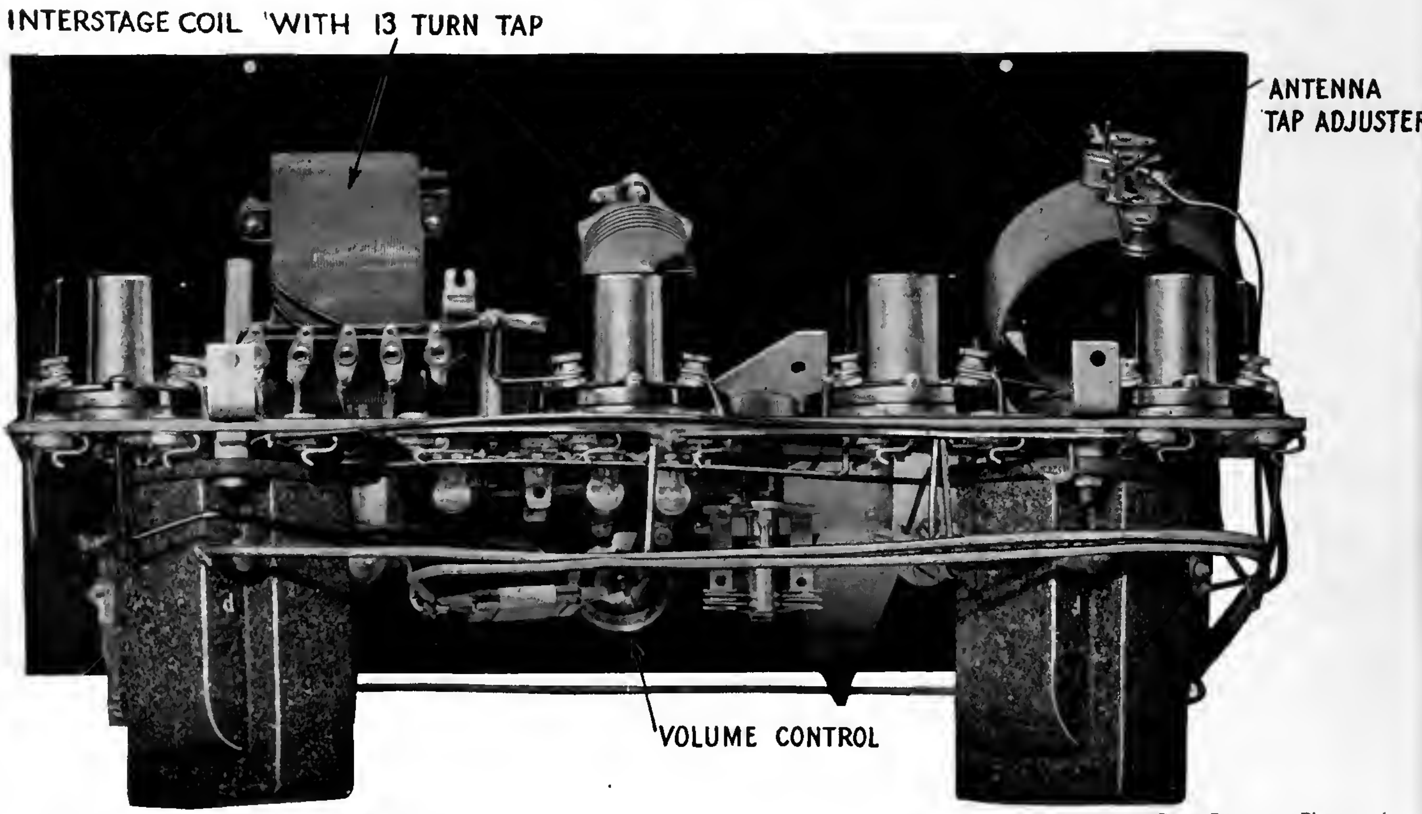
How the coil and r.f. choke fit into the detector circuit is clearly indicated here. This circuit may be used for cross reference with the detector circuit diagram in Fig. 4

tendency to give the amplifier a "flatter" characteristic, that is, the amplifier will amplify all frequencies very nearly alike.

Listening-in with headphones before the first audio stage, one finds there is sufficient volume

FIG. 7

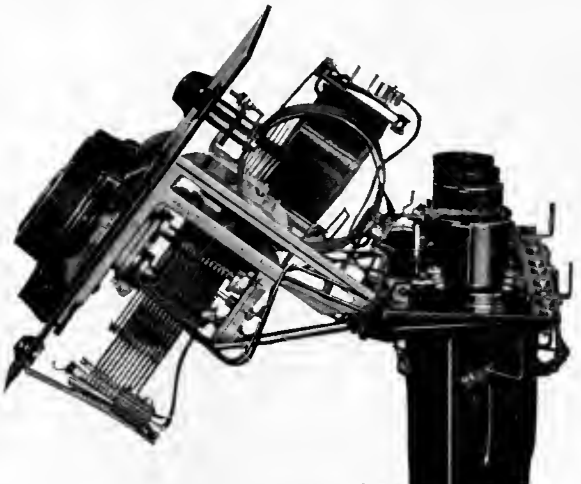
Notice that the detector coil unit in its new position is on the same plane and at right angles with the antenna coil unit. The regeneration condenser located in the hole formerly taken up by the tickler is a 15-plate Hammarlund Midget condenser of 0.000065 mfds. capacity



Radio Broadcast Photograph

to work head phones in a very satisfactory manner. To make it possible to change readily from the last audio stage to the first audio stage required nothing more than the inclusion of a jack in the primary circuit of the first stage audio transformer. At the same time, it was found desirable to have some automatic means of turning off the last audio amplifier filament when the phones were used on the first stage. Filament circuit jacks did the trick and their connection into the circuit is shown in Fig. 9. To employ this type of jack in the circuit shown, sometimes necessitates alterations being made to the jacks obtained, however. In the circuit described in this article, two No. 105 Carter jacks were taken apart and the blades rearranged so as to correspond with the blade positions as shown in the accompanying circuit diagrams.

With the addition of filament circuit



RADIO BROADCAST Photograph

FIG. 8

The output jack for the loud speaker has different control blades for cutting in and out the filament circuit. Comparison between the two types of jacks employed can be made by referring to the revised circuit diagram Fig. 5

CAST Laboratory Information Sheet No. 12, in this issue. Needless to say, the output jack too is of the filament control type so that when the plug is inserted in the last stage, all the tube filaments are lighted. When inserted in the first stage jack only the first three tubes, r.f. amplifier, detector and first audio stage, are lighted.

For a tuning control refinement, Na-Ald vernier dials replace the ordinary dials with the result that sharper and more accurate tuning is accomplished.

The circuit then, in its completed form, consists of one stage of tuned, neutralized radio frequency amplification, a detector employing capacity feedback with choke coil in the audio circuit, filament control jacks for first and second audio stages, an approved volume control, and power tube output. These changes are shown complete in Fig. 5.

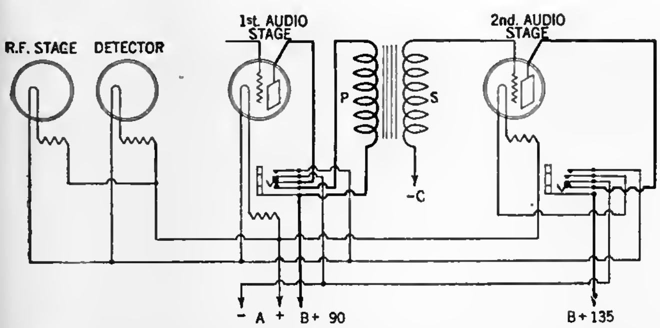


FIG. 9

Filament control jacks permit the loud speaker or phones to be plugged from the last stage to the first stage of audio amplification and automatically control the filaments of the tubes so that only those tubes actually employed to receive the signals are lighted

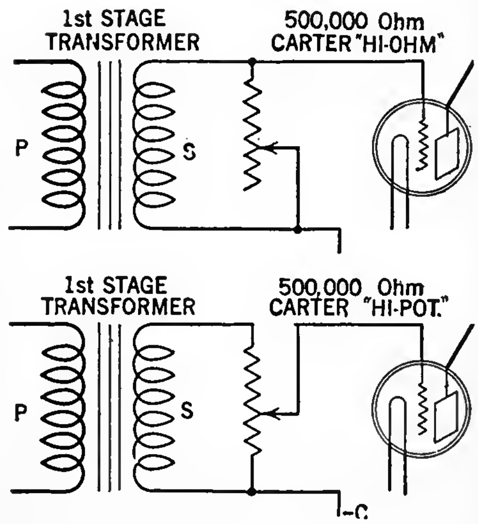


FIG. 10

Two volume control methods are shown here. The volume may be brought from its full value down to a mere whisper. With this control, clarity of signal is also improved because with its intelligent regulation overloading is prevented

jacks it becomes unnecessary to continue using the filament switch and by discarding it, the first audio jack may be mounted in the switch hole.

The 500,000-ohm variable resistor, which may be either the new Carter Hi-Ohm unit or Carter Hi-Pot unit, is mounted in the hole previously occupied by the rheostat.

POWER TUBES FOR THE LAST STAGE

As a final circuit change, one of the parallel tube sockets in the last audio stage is removed and its Amperite is wired in the circuit to control the filament of radio frequency stage. Then in the remaining last stage socket a UX-112 or UX-171 tube is employed as a power stage. It will be found that the grid-plate shunt condenser for the last stage may be removed when the power tube is employed.

For the 112 type of tube, at least 135 volts of B battery with 9 volts of C battery will be found necessary for good tonal results. With the UX-171, 180 volts of B battery with 40.5 volts of C battery will furnish well-nigh perfect tone output. For detailed information on this tube, the reader is referred to RADIO BROAD-

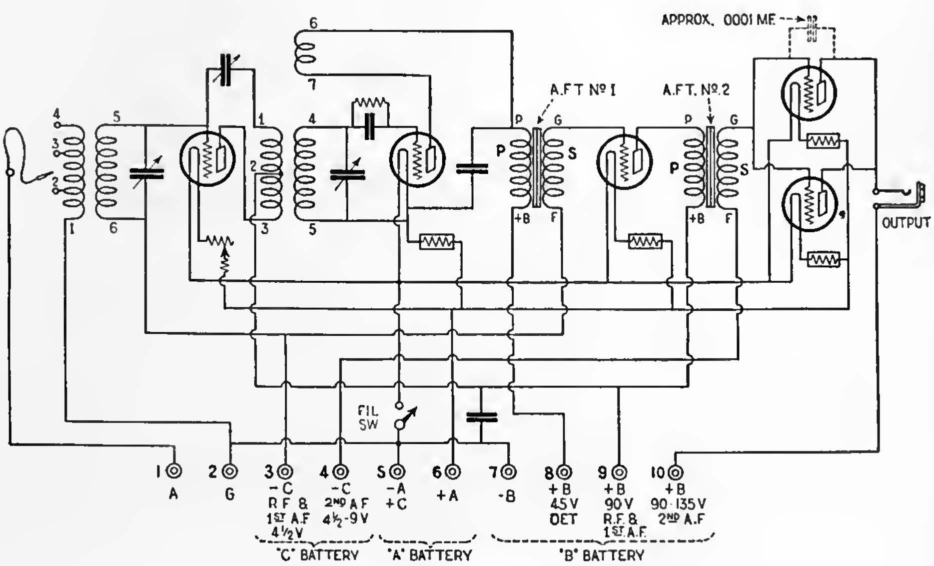


FIG. 11

This is a diagram of the original Hammarlund-Roberts—as it was before the changes described in this article were made. Compare this diagram with that shown on the previous page, and note the alterations

LIGHTNING PLAY BETWEEN CLOUDS

Discharges of this sort produce severe static which is not heard over very great distances

Where Summer Static Comes From

How the Thunderstorm Affects the Radio Set—What a Thunderstorm Is and the Localities Generally Affected—How to Produce Local Static Experimentally—Various Types of Lightning and Its Source

By B. FRANCIS DASHIELL

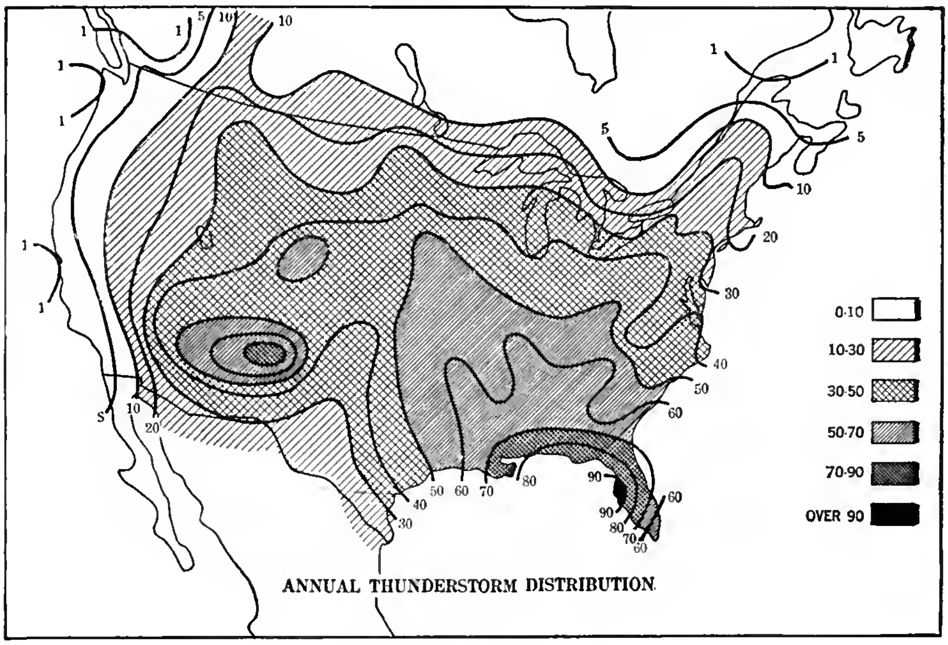
IT IS almost an open secret that during the summer months, the reception of radio programs is quite apt to be interrupted by rolling of static in the loud speaker. Sensible folk do not criticise radio for this shortcoming of static, but rather praise the art for its great advance. They look on static as an annoyance, certainly, but believe that the presence of an obstacle like static contributes much to the advancement of the art because it gives the engineering folk a goal to strive for. This article by Mr. Dashiell tells a good deal of interesting information about the parenthood of static, particularly the varieties common in summer. The article is authoritative, besides being "good reading." Mr. Dashiell is a member of the Institute of Radio Engineers and also of the American Meteorological Society.—THE EDITOR.

THE thunderstorm is well known to everyone, for there are very few inhabited portions of the globe that are free from this phenomenon. It may be defined as a storm that occurs locally at all places along its path, lasting from but a few minutes, to an hour or more, and evidently moving slowly across the country, sometimes for a considerable distance and again but a few miles. The approach of the thunderstorm is heralded by several phenomena which usually follow a fairly well defined order of succession. There is a very close and definite association between these storms and radio reception conditions in summer. During the approach of a thunderstorm, and while it is in progress, static interference becomes so great that satisfactory radio reception is practically impossible on an outside antenna. The static noises die away with the passing of the storm, but many such outbursts, due to distant lightning, may be noted for a number of hours although with diminishing frequency and intensity.

DIAGNOSIS OF A THUNDERSTORM

AFTER nearly a full day of fairly clear weather, with perhaps a suggestion of light southerly breezes, a general calm sets in and the air becomes very oppressive. The humidity is noticeably high. A few clouds of the cumulus type have been drifting lazily across the sky during the day and, as the afternoon progresses, they have gradually increased in size and number until the entire horizon becomes well banked. The muttering of the thunder from distant lightning becomes audible, growing louder and louder, and before long, the entire lower stratum of clouds may be seen to be advancing rapidly. Static interference in the radio set has been increasing greatly during the past hour or two, and, now, with the sound of thunder, the static crashes become so loud that the radio should be shut off and the antenna grounded. Little gusts of warm wind begin to blow toward the advancing storm from an opposite direction, becoming stronger. The air feels oppressive. As the clouds become lower and darker, the first few drops of rain fall while the wind now suddenly shifts into the same general direction taken by the advancing storm. The wind increases, blowing dust ahead of the cloud, and heavy rain begins to fall in torrents. Lightning that has been occurring sporadically before the rain, now becomes more frequent and more severe. This portion, or the center of the storm, may continue but a few minutes or perhaps an hour or more, depending upon the intensity of the disturbance. After the greatest period of wind and rain severity has passed, the lightning diminishes and finally ceases locally, although a light rain may set in and continue throughout the night. If the storm passes during the late afternoon, the clouds will break away and the rear of the great cumulus-nimbus clouds of the storm, with the great dark rain area beneath, can be seen with the sun lighting them up from the western sky, but through which nothing can be seen except the flashes of occasional lightning. With the passing of the storm, the lower atmosphere becomes cooler and drier, the sky nearly clear of clouds and a pleasant breeze sets in from a westerly direction.

Static interference practically diminishes as the atmosphere clears of all electric producing phenomena, although the distant lightning will still continue to set electromagnetic waves in oscillation which will be heard in the radio set for some time afterward. It is not the sound of thunder that is heard in the radio set, but the actual wave that is propagated by the electric spark, or lightning flash. Thunder is merely the sound of the air as it rushes in to fill the space or vacuum made by the passing of the spark. Such a wave will be heard simultaneously with the visibility of the flash, but ahead of the sound of the thunder. Electromagnetic waves travel at the same speed as light waves, 299,725,000 meters, or 186,000 miles per second, while sound travels but approximately 1000 feet per second.



THUNDERSTORM HEADQUARTERS

The chart shows the annual distribution of thunderstorms over the United States. The greatest number of storms occur in the vicinity of Tampa, Florida, and the least number along the Pacific Coast. The large number of storms occurring over the Southwest, especially in Arizona and New Mexico are usually unaccompanied by rain, and are due to hot winds and dust. Storms elsewhere are accompanied by rain and considerable static, while electrical dust storms give rise to local static of short duration

THUNDERSTORM REGIONS

THERE are certain regions which produce more thunderstorms than others, and there are certain weather conditions, as shown by the daily weather map, favorable to the inception of thunderstorms. Purely local storms of a sporadic character may be caused by local regions of warm air within a high air pressure area and predominating clear sky. These give rise to local static only, last but a short time, and seldom cross over much territory. There are thunderstorms which occur chiefly in the regions of southerly winds, either to the southeast or northeast of a low air pressure area, probably caused by local topographical conditions and consequent upward deflection of the warm surface winds, all of which stimulate the formation of large cumulus clouds. These storms have considerable static associated with them, not entirely due to the storm itself, but also to the meteorological elements of the central low air pressure area to which they are attached. Some of these disturbances will be of the nature of a mere thundershower while others will be intense thunderstorms. Even after the passing of the storm, static will exist as long as the electric influence of the central "low" is felt. The most severe of all thunderstorms occur south or southeast of a central low air pressure area along a line or front of a great mass of cooler and drier air which is slowly descending from the upper atmosphere and underrunning or lifting up the warmer and moister air ahead of it. Much static predominates, not only from the central low area itself, but from the mechanical action of the vigorous air currents. Lightning associated with such storms is very severe and spreads out over a large area, affecting radio receivers over many miles, often a whole state, or more.

Thunderstorms occur in nearly all parts of the world, but the number decreases rapidly as we pass from the equator toward the pole. In the tropics, there are many places that nearly average a thunderstorm for every day of the year, while in the far north but one or two storms may occur in the course of several years. Fewer storms occur over the ocean than over land, and mountainous regions have far more than the level plains. In the United States, the largest number occur over the Gulf States. In New England there occur but approximately one-fourth of the thunderstorms experienced along the Gulf, while at certain Pacific coast sections the proportion is very small as such storms are rare.

Let us now go behind the scenes and look into the mechanics of the thunderstorm and the production of summer static.

POWERFUL LIGHTNING DISCHARGES BETWEEN CLOUD AND EARTH

Discharges of this sort are the source of severe static which can be heard over great distances

WHERE SUMMER STATIC COMES FROM

THUNDERSTORMS have their origin in masses of warm and moist air. This air rises because of convection, cools be-

AFTER THE STORM

Alto-cumulus clouds follow the breaking up of the storm and precede the clearing of the sky. A fresh breeze and cooler weather accompany these clouds, but little local static will be observed

cause of expansion and therefore reaches a vapor point, resulting in the formation of a cloud. Practically, only clouds of the cumulus family are so built, but they may become overgrown and the condensation of moisture is sufficient to cause precipitation. The cloud has now become a cumulus-nimbus cloud with strong descending air currents forming beneath it, which push forward as they reach the earth and displace the warm air which is ascending and being condensed into vapor, or cloud, as above explained. In the region between the descending cool air and the rising warm air, a vigorous eddy forms and can be seen as a turbulent squall cloud rolling along in advance of the cumulus-nimbus thunderhead. The air pressure rises and the temperature falls when this squall cloud passes due to the descending cool air, of greater density, in the rear of the turbulence. Rain now falls in torrents and the lightning flashes follow in close succession. Hail may fall depending upon the degree of expansion that the rising air passes through, resulting in a lowering of temperature, and the presence of snow and freezing weather toward the tops of the clouds. Storms of this character should occur with greatest vigor when large masses of warm and moist air are present, during the hottest time of the year and the hottest part of the day. The natural requirements are therefore in good accord.

In order that condensation may form and rain begin to fall, it is necessary that some sort of particles be in the air to form nuclei upon which the moisture can condense or collect. These nuclei are very minute, but as they slowly pass through the clouds, they collect and attract moisture and become larger until, overcoming the upward air currents because of the attraction of gravity, they fall as rain. Dust particles serve as nuclei as well as ions, or electrically charged portions of atmospheric gas. The number of ions in the atmosphere is by no means constant as they are produced through many causes. Warm, moist air which, due to convection, is in rapid motion and is highly conductive. The action of the air currents produce ions through dissociation or the removal of an electron from an atom of atmospheric gas. Still again, when moisture is condensed on the various types of nuclei and rain drops form, they are constantly broken up or combined before they fall upon the earth beneath, an action which divides or increases their individual charges until the atmosphere becomes highly charged. When these raindrops, as well as the air molecules, are broken up through impact and friction, both positive and negative ions are given off, but whenever a negative ion is given off, the raindrop retains a positive charge and is believed to bring down much more of that kind of electricity to earth. The removal of one kind of charge from a cloud must leave a charge of opposite kind on the cloud. As there are many detached clouds within the thunderstorm and different charges arrange themselves along the upper and lower surfaces of the clouds, through attraction and induction, many differences in potential must exist between points in the atmosphere. They may become zero through negative differences in potential, and they may attain values so large that a breakdown of the dielectric, or air gap, will eventually take place and the lightning flash will result.

WHAT A LIGHTNING DISCHARGE IS

IF A cloud is a thick one, or the rainfall is quite heavy, the charge may become very large, and such clouds are likely to be attended by lightning discharges. Eventually, the potential difference between the cloud and the earth becomes sufficient to cause an electric spark to pass between the two. Again, different parts of the same cloud, or different clouds, may become so charged with different kinds of electricity that internal lightning flashes will result. Lightning occurring between clouds probably occurs more often than between cloud and earth. The air gaps are less with constant changes in distance between clouds while between clouds and earth, the distance may be as much as a mile. While appearing to be a single spark, a lightning flash does not pass from the cloud to the earth, but travels rapidly back and forth a number of times, in a time interval of perhaps less than a thousandth of a second. A lightning flash is, therefore, an oscillatory discharge lasting but an extremely short time and capable of generating a powerful electromagnetic wave. It has been estimated that at least 20,000 amperes of electric current are liberated in an ordinary discharge. The voltage greatly varies, depending upon the length of the discharge. When we consider that many millions of similar flashes take place throughout the world every day, propagating electromagnetic waves with an electric power that exceeds by many thousand per cent., that used by the greatest radio stations, it is small wonder that static is practically forever present in some amounts in sensitive radio receiving sets.

Lightning that occurs between clouds and clouds and the earth is usually zig zag in appearance. It is an electric spark on a tremendous scale. There are several causes that contribute to give it this shape. The most general of these are various layers of different temperature, density and ionization in the atmosphere. Refraction is therefore different and a broken line appears; the eye is somewhat blinded by the glare, and much of the finer detail is lost. The electric discharge also follows the lines of least resistance or from one mass to another which contains the heaviest ionization and continuity of conductivity.

STATIC IN POCKET EDITIONS

EVERY meteorological action within the development and existence of a thunderstorm is incident to the production of atmospheric electricity. The breaking of a raindrop into two separately charged portions gives rise to a minute electromagnetic wave. This may be simply demonstrated by placing two small sheets of thin paper together and rubbing them with a piece of cloth so that they become electrified and adhere together. Hold them over the radio set and pull the sheets quickly apart. The discharge will make a loud static crash in the loud speaker. Other charges of greater value are neutralized and set up waves that reach the radio set at least an hour or more before the storm develops locally, while the waves from distant lightning may be heard some hours before the storm approaches. As a rule, however, when the weather is such that thunderstorms will develop in the late afternoon, the mechanical production of ionized atmosphere takes place throughout a period of several hours before the storm and considerable static will be heard. Directional radio compass apparatus will locate the general direction of the region of static or the approaching thunderstorm. Local static in the atmosphere surrounding the set will have no directional effect on the apparatus. In some cases, the increase of static will foretell the development of a storm within a few hours. With the passing of the storm, local atmospheric electricity is cleared from the atmosphere and static interferences rapidly diminish.

Small patches or areas of ionized and positively charged atmosphere come into contact with the antenna and are discharged, or falling rain drops add their slight charges to the antenna, so that static discharges pass into the radio set and produce these spasmodic noises we know so well. Such a method of producing static may be termed "shock excitation." Other discharges, between clouds, clouds and earth, or even between small charged masses of gas, will generate oscillatory electromagnetic waves which will be picked up by the set in much the same manner as any radio wave. Since these waves are so similar to radio waves, there is no way to tune them out as they are propagated on all frequencies within the limits of electromagnetic waves. The small amount of electricity necessary to produce static may be demonstrated by passing a rubber comb through the hair and then touching it to the antenna. A powerful static crash will be heard instantly in the loud speaker.

Other kinds of lightning, such as sheet and heat types, which also produce electromagnetic waves, deserve some consideration and explanation.

Sheet lightning is applied to the sudden lighting up of a whole cloud as if a curtain were suddenly drawn aside to disclose the bright cloud. The duration is quite long, a second or two, and usually occurs during a thunderstorm, or, at least, thunder may be heard. It may be a brush discharge around the edges of the cloud and it may also be due to the reflection of a flash of lightning some distance away.

Heat lightning has been applied to the sudden lighting up of the atmosphere, usually when it is hazy but when no distant or approaching thunder is audible. This form of lightning is so indefinite that it is hard to localize and thunder is never heard. Considerable static interference will be heard which is indicative of electric discharges taking place at some remote place. In this case, directional radio apparatus would locate a storm area beyond the scene of heat lightning. This form of lightning is simply the reflection on the hazy atmosphere of a thunderstorm below the horizon.

HOW A THUNDERSTORM LOOKS FROM A MOUNTAIN-TOP

A view taken from Mount Wilson, in California, which shows very clearly the composition of a thunderstorm. The shadow of the advancing clouds may be seen on the valley floor beneath, and the dark cumulus-nimbus clouds with rain, following from the left. Accompanying static is severe

The Listeners' Point of View

Conducted by ..... John Wallace

A Genuinely New Type of Radio Program

HAVE we ever expounded our theories concerning radio novelties? Well, we're agin 'em. And for the reason that, more often than not, they are merely novel, with nothing further to recommend them. Tricks, in the long run, always become boresome and uninteresting. To elucidate our point: one good jazz band that consistently plays honest American jazz, well orchestrated and devoid of trimmings, is worth a dozen fly-by-night bands that are purveyors principally of trick effects and quite devoid of any understanding of the fundamental good points that jazz does possess.

In general this is true of every type of program. It is the quality, not the novelty, that counts. You have seen second rate vaudeville comedians come out with a bag full of tricks and a stage full of props and yet achieve a complete "flop." The headliner strolls casually on the stage attired in business clothes and, without even a chair to sit on, brings down the house by the sheer quality of his performance

We do not mean to disparage novelty completely, since we are by no means immune to the universal craving for it. But it is meritorious only when it is combined with quality. It can't stand on its own legs. And that combination, unfortunately, is a *rara avis*. So we think that the time and money expended by program directors in a frantic search for something new and different could much better be utilized in ferreting out better artists.

Well, let that be an indictment of novelty for novelty's sake. And now to prove the foregoing statements by citing the inevitable exception: The "Old Time Prize Fights" that have been heard lately from WGN constitute, perhaps, the most ingenious program innovation of the year.

As far as our listening experience indicates, the idea is an entirely original one—that of recreating an historical event and broadcasting it as though it were actually taking place.

There is no kinship between this and the broadcasting of an historical play or sketch. Radio versions of the Landing of Columbus and the Storming of the Bastille, and so forth, have already been heard. In such presentations the listener is asked to imagine himself present at the scene in question. By dint of imagination he must transfer himself from Peewaukee, Idaho to Paris, France and mingle with the mob before the Bastille. Such a jump is quite a chore, and in consequence the illusion of reality is fleeting and hard to capture. In the WGN stunt, all that is asked of you is that you forget the date on the wall and overlook the fact that radio has not always existed—nothing more. You are still, for all purposes of the illusion, seated in your front parlor before the loud speaker, but the event, the progress of which you are following, is in reality long passed.

The first of the series of "Old Time Prize Fights" was the famous battle between Jake Kilrain and John L. Sullivan for the "championship of the world," the last boxing match in this country under the old London Prize Ring rules, which have been superseded by the present Marquis of Queensbury rules. The fight took place on July 8, 1889, in Marion County, Mississippi. Gray-beards among fight fans will recall how the two stalwarts battered each other under the glaring sunshine of that hot July afternoon, with Sullivan finally emerging as the victor.

Listeners were asked to turn back the calendar and imagine themselves in the last century. Then we were informed "this is WGN broadcasting the Kilrain-Sullivan fight by leased wires from Marion County, Quin Ryan announcing. And in a very few minutes we were entirely convinced that the statement was a fact. The familiar murmur of the crowd, always audible in a sporting event broadcast, could be heard. Occasionally the shouted remark of some spectator nearer the microphone could be distinguished. A roar from the crowd evidently heralded the appearance of the fighters, and a moment later the gong sounded.

Mr. Ryan's excellent portrayal of a frenzied announcer, all but carried away by the excitement of the match was largely responsible for the effectiveness of the illusion. Another factor was the accuracy of the noise effects; for instance the shouts of the darkies selling corn cakes and molasses between rounds. No one who chanced to cut in on the program without hearing the introduction could have helped but believe that he was listening in on a sure-enough prize fight.

Other fights in the series have been the Sullivan-Corbett bout, the Fitzsimmons-Jeffries fight, the Jeffries-Johnson battle and the well remembered fracas between the famous colored fighter and Jess Willard, who preceded Jack Dempsey as champion of the world. The running stories of the fights were, in each instance, derived from old newspaper reports and from eye witness descriptions of the scene. The staging, of course, took place in the station's studio.

The re-creation of prize fights, noble though it may be, does not, we think, by any means exhaust the possibilities of this ingenious program device. While it would take more thought than we have the ambition to put in at present to devise further variations, we are sure many would present themselves after proper research. Have you any suggestions?

The re-enacting of some important political event, say a coronation or a parliamentary session might work. Or a famous trial could be repeated, making use of the court stenographer's record. The possibilities are numerous but restricted by this important consideration:

MRS. K. G. POLYBLANK, NORTHERN QUEBEC

How's this for a change on a hot June day? Mrs. Polyblank, shown with her children near her Northern Quebec home was the principal in one of the most interesting "human interest" broadcasts of the year. She had performed a most unusual act of heroism in plunging from a boat into the icy waters of Long Lac to rescue a child who had slipped from the moving craft. She was awarded the life-saving medal of the Royal Canadian Humane Association. The presentation speech was made by Sir Henry Thornton, president of the Canadian National Railways, through CNRO. At the same time, an official of the Society pinned the medal on Mrs. Polyblank, after a journey to her almost inaccessible home

ALLAN W. FAIRCHILD
Originator of the "Blue Monday" programs from KNRC

could the event (if radio had existed at the time) have been broadcast by ordinary means? For instance: an acquaintance whom we consulted suggested that the destruction of Pompeii would make a thrilling subject for such a broadcast. The catch is that a radio station, conceivably existing in Pompeii in 79 A.D., would have been all too soon put out of commission by the falling ashes and the inevitable static to have continued broadcasting through the holocaust. Besides, in the interest of absolute realism, the announcer would have to talk in Latin! But the idea is suggestive.

Painless Ways of Improving Radio Programs

COÖPERATION from radio listeners is urged by Officials of the Radio section of the Department of Commerce, as the next step in perfecting radio broadcasting.

The Department has gone as far as it can under present appropriations, the broadcasters are striving to give the fans what they want, and the industry itself is improving both transmitting and receiving apparatus, but the big thing remains undone, according to Chief Radio Supervisor W. D. Terrell. The fans don't tell the stations what they like; at least, not enough of them report on programs.

Some may think this is unnecessary; others that it is desired only for the publicity value to broadcasters, while many will admit that they are too lazy to send a telegram, letter, or postal. However, Mr. Terrell is very serious in his suggestion, urging that fans assume the responsibility which rests upon their shoulders and let the stations know whether they like a program or not and why.

In this country there are no fees charged for listening-in and no taxes for owning and operating a receiving set. Some fans appreciate this, but yet seem unwilling to fulfill the requirement of reporting frequently to their favorite station managers what in their opinion is good and also what seems bad or poor.

By an accumulation of reports from near-by and distant points—and only through such returns—station managers can judge whether or not programs are getting over; whether the fans are pleased, disappointed, or peeved at entertainment offered.

The paragraphs above are from a Washington bulletin, and we heartily endorse it. The second page of the bulletin, continuing the subject, had much to say about the listener's duty to the broadcasting station; how he owes it to the station to send in critical comments as his just compensation for the entertainment offered "gratis." That page now gently rests in our waste basket.

We are sickened unto tantrums by all such talk about the listeners' duties to the broadcasters. The listener has no duty to the broadcaster. Broadcasters are not in the business for philanthropical purposes. The Association of Broadcasters is no glorified Salvation Army. If their programs are offered "gratis" as a "gift" it is as impolite for them to call attention to the fact as it would be for us to remind Aunt Susan that we gave her a pair of stockings last Christmas and she ought to be crashing through with a necktie for our birthday.

We join in urging the fans to send communicados to the broadcasters, not because they owe it to the broadcasters, but because they owe it to themselves. For truly, cussing out a punk station to your neighbor is not going to improve matters a bit; whereas a letter to the station advancing the same complaint is bound to have an affect. Obviously, a station cannot afford to ignore letters from its customers when its business is entirely dependent upon pleasing its customers.

Of course, the writer need not imagine that his letter is going to have an immediate and revolutionary effect on the station's policy. The manager's private secretary will not immediately rush into the boss's sanctum sanctorum waving the letter about and shouting, "We just got a note from Timothy Doe out at Oshkosh and he says he doesn't like sopranos! Shall I go fire them all?"

The letter will probably be received by a professional letter opener who will glance through its contents as quickly as possible and enter them concisely on an imposing looking form drawn up by some inspired statistician. But such a procedure, if more impersonal, is likewise more provocative of results. For if the column in the letter-reader's book entitled "Dislikes Sopranos" reaches a dangerous length the program director will be promptly advised, and in the interest of efficient business methods soprano's voices will be heard no more from that station.

NORTON H. PAYNE
Organist of the Capitol Theatre, Montreal, heard through CKAC. When a popular entertainer faces the microphone and gives a special number which has been requested by 500 fans, arrangements are made with a local phonograph record manufacturer and one of these two numbers are registered via CKAC through the recording laboratories of the local firm. A program by Mr. Payne was the first to be so recorded

CYNTHIA GREY
A Denver newspaper columnist. She conducts KOA's newest afternoon broadcast attraction for women—microphone snapshots of human nature

The British Broadcasting Company—as do many American stations—uses such a system of cataloguing correspondence. In their own words:

Of course, it is not practicable to build programs in absolute accord with the views of individual listeners, but the cumulative effect of all our program correspondence gives a sound indication of the trend of public opinion.

The mail, as it comes in each day to the Program Correspondence Department at the central office at Savoy Hill, is carefully sorted after perusal, there being three main groups into which letters fall, viz.: (1) Criticism; (2) Appreciation; and (3) General—the latter term including letters of inquiry, request, suggestion, or, in fact, any letter which calls for some kind of reply.

It is impossible, and in most cases it is not desired, that a reply be sent to postcard messages of appreciation; similarly, letters expressing enjoyment of an item, artist, or program can only be briefly acknowledged by card. All other letters, however, do receive considered answers, and in cases of criticism a real effort is made to explain to the correspondents the reasons which caused them to complain; and in some cases, if a matter is brought to light which should be remedied, steps are taken to avoid a repetition of the trouble.

A daily *précis* of this correspondence is prepared and circulated, not only to members of the Program Board, who are responsible for the construction of the programs, but also to other officials who are directly concerned with program building. This *précis* shows in detail all appreciations and criticisms of program items, and, in the case of the latter, the actual letters of criticism are also circulated. Requests and suggestions of a general character are also noted on the *précis*, whereas those of a specific nature are sent to the individual departments concerned.

Listeners should realize that their letters are indeed "read, marked, learned, and inwardly digested."

What Radio is Like in the Far West

WITH DX conditions as unsatisfactory as they have been the past several months it has been difficult to get a comprehensive idea of what goes on in the great open spaces west of the Rocky Mountains. Accordingly we have solicited the opinion of Mr. James L. Marshall of the *Seattle Star* concerning Pacific Coast programs and he has the following to say:

"The Pacific Coast program still is in the song-and-dance stage of development. It runs largely to impassioned announcements by sopranos, altos, bassos tenors and mixed quartets that they want to be like a tree, as per the Rasbach ode; to appeals by male duets to 'Remem-bah!' via Irving Berlin; to talks on the care of the hair and scalp, by lady beauty-parlorists; to details of what's what on the public market stalls; and to renditions on saxophones, oboes, clarinets, ocarinas, pipe organs, and musical saws of 'That Certain Party.'

"There has been lately, a tendency to cater to women listeners by putting various women's clubs and federations on the air for afternoon programs—and this is a step in the right direction. But a comprehensive plan for taking radio out of the primary class and making it intelligent still seems lacking.

"The advertiser in the West still is the bane of studio managers. Very few of them have been 'sold' to radio; hardly any of them realize what radio is all about. They insist on frequent and comprehensive announcements of their names, location, bargains, stock in trade, slogan, and business ethics, if any. And they cannot be convinced that this wins them, not good will, but a turn of the dials to another station.

"Some intelligent managers of studios are doing missionary work, trying to instill into advertisers' minds the idea that radio is merely an *n*th power extension of the Chautauqua. But, up to now, they have had little success.

"One coast station and one in the Rockies have adopted the Chautauqua idea—and the results have confirmed its success. But while KGO at Oakland, and KOA, at Denver, really offer popular education, a score of other stations do no good for themselves or anybody else by insisting that chatty talks about hair restorers, patent budgets and the history of pants pressing and general laundry work are 'educational.' State colleges in Washington and Oregon, and the University of Montana, are running three-times-a-week courses, appealing generally to farmers, fruit growers, and stockmen. But they are small stations, generally run as an appendix to a department, and are not very effective. Neither do their courses appeal to the city radio fan, who is largely in the majority.

"But, even so, radio is producing some new ideas on the Coast. One studio, operated by KTCL, the north coast's largest station, has tried to visualize for its artists and speakers, their audience.

"Hanging in the studio is a large photograph of a working man's wife, with her babies. Printed matter, with the picture, says: 'This is Mrs. So-and-so, living at 1000 Blank Street.' It goes on to tell who Mrs. Smith is; what she likes; and what she does; what her husband is, does and likes—a family history in short. And the end of the story says: 'You are a guest in Mrs. Smith's home while you are on the air. She is your "average listener." Broadcast for her.' Never an off-color song or story goes out on the air over that station.

"Eastern studio managers will be surprised to know that time over some thousand-watt Western stations may be bought for as low as $10 and $15 an hour, contrasted with the hundreds of dollars for the same privilege in the East.

"But the Western audience is scattered, not concentrated. The broadcaster who gets 200 letters a day counts himself successful. The average audience, except for outstanding events, probably never exceeds 15,000. Perhaps 10,000 would be a better figure. KGO's Monday 'educational night' broadcast and the weekly dramatic broadcast of well-known plays from the same station, generally are conceded to have the biggest audience west of the mountains.

"While the problem of the Eastern fan is to separate stations, the problem of his Western brother—and sister—is to get distance. He is not bothered particularly by crowded dials, but he demands a receiver that will give him loud speaker volume at 1000 or 1500 miles.

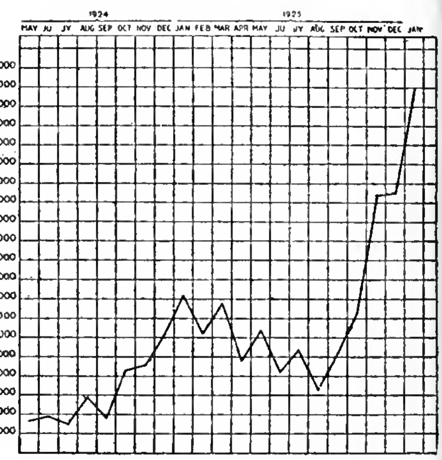
"Congestion is rapidly becoming a problem in the West, though California, at the last count, had 62 stations, most of them on the air every night. The same state has more 'religious stations' than any other. Some of the 'revival broadcasters' even run to church orchestras, putting popular selections on the air.

"The coast fan, as a rule, is not luckily situated for Eastern or Midwestern reception. Much of the coast is in a 'radio shadow,' cast by the Sierra Nevada, the coast range, the Cascades or the Rockies. Thus, WJZ, with enormous power, is scarcely ever heard with any volume west of the ranges. Yet Mexico City stations, with one-hundredth of the power, come in with loud speaker volume on the average set on a good night. North and south the coast fan gets good reception; east and west it's 'not so good.'

"Reception of Japanese stations is becoming common; Alaskan fans are reporting reception of a few Australian stations; and Honolulu comes in with fair regularity on the crowded 1090-kc. (275-meter) band. Incidentally, those fans who want to log the Japanese stations have to stay up until 2 and 3 A.M. to do it. The Orientals sign off just when most coast folks are getting up

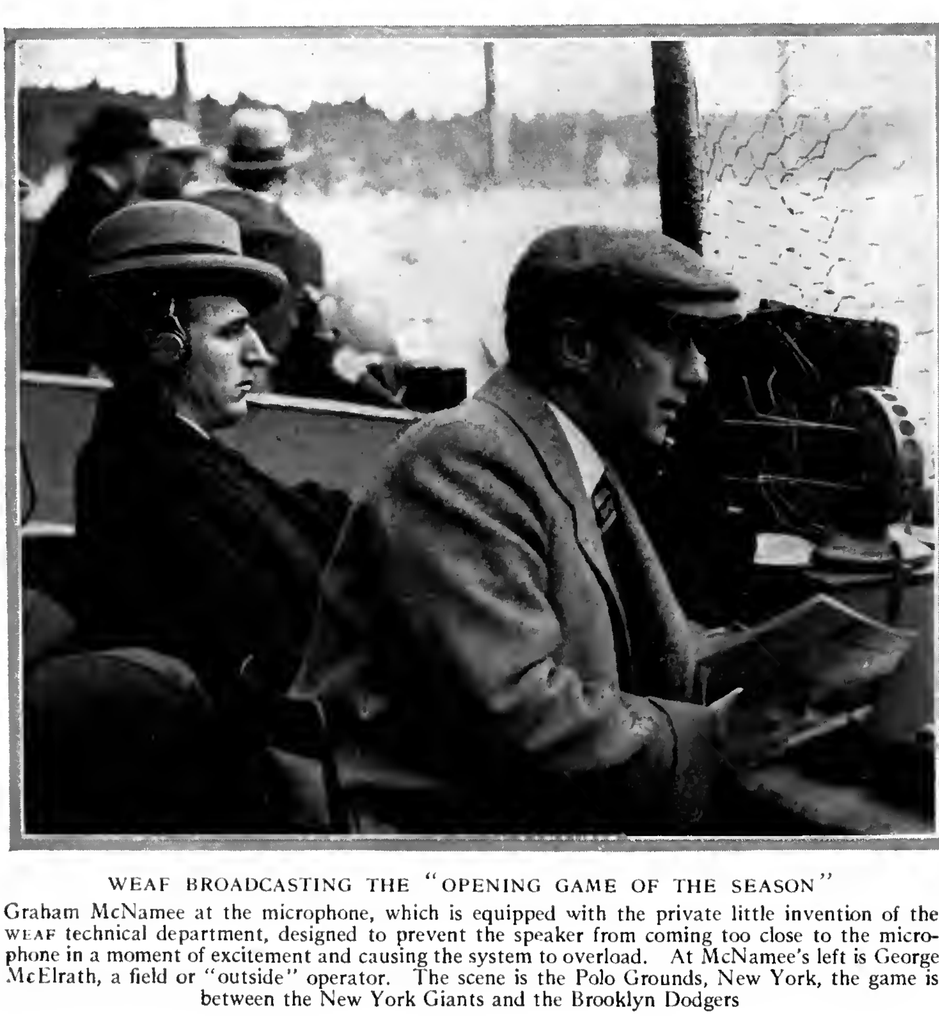
"In entertainment, in technical excellence of broadcasting, in educational features, the West coast fans still have much to be desired. They are learning, however, that a well-modulated 500-watt station is to be preferred to a badly operated 5000-watter; they are coming to realize that programs may be vastly improved, and are demanding the improvement; and they are coming to know some of the difficulties of broadcasting. But there are still no fighting radio clubs on the coast, as in Chicago and Eastern cities. 'Silent nights' are conspicuous by absence. Definite cleaning up of power-line and other interference is a hit-or-miss proposition as yet.

"Radio in the West, for the greater part, still is primitive."



HOW THE BRITISH WRITE THEIR STATIONS

A chart showing the quantity of letters addressed to the various stations of the British Broadcasting Company during the last two years. The chart is reprinted from a recent number of the *Radio Times*



WEAF BROADCASTING THE "OPENING GAME OF THE SEASON"

Graham McNamee at the microphone, which is equipped with the private little invention of the WEAF technical department, designed to prevent the speaker from coming too close to the microphone in a moment of excitement and causing the system to overload. At McNamee's left is George McElrath, a field or "outside" operator. The scene is the Polo Grounds, New York, the game is between the New York Giants and the Brooklyn Dodgers

Educational Broadcasters Association Formed

JUST to demonstrate how broad minded we are—for we think most educational broadcasting is the bunk—we here record the fact that an association of educational broadcasters has been formed viz: The University Association of Broadcasting Stations. A considerable expansion of educational broadcasting is contemplated under the direction of Dr. C. A. Culver, Carlton College, Northfield, Minnesota, and J. C. Jensen of Nebraska Wesleyan University. Members of the association at the time we write include the following:

WHA, University of Wisconsin, Madison, Wisconsin; WEBW, Beloit College, Beloit, Wisconsin; WEAO, Ohio State University, Columbus, Ohio; KFMX, Carleton College, Northfield, Minnesota; WOI, Iowa State College, Ames, Iowa; WKAR, Michigan State College, E. Lansing, Michigan; WMAZ, Mercer University, Macon, Georgia; and KFMR, Morningside College, Sioux City, Iowa.

Also WBAO, Millikin University, Decatur, Illinois; WPAK, North Dakota Agricultural College, Agricultural College, North Dakota; WHAD, Marquette University, Milwaukee, Wisconsin; WEW, St. Louis University, St. Louis, Missouri; KUSD, University of South Dakota, Vermilion, South Dakota; WTAW, Agricultural and Mechanical College of Texas, College Station, Texas.

And KFUT, University of Utah, Salt Lake City, Utah; KWUC, Western Union College, Le Mars, Iowa; WABQ, Haverford College Radio Club, Haverford, Pennsylvania; KFDY, South Dakota State College of A. & M. Arts, Brookings, South Dakota; KFMQ, University of Arkansas, Fayetteville, Arkansas; WSUI, University of Iowa, Iowa City, Iowa; and WCUW, Clark University, Worcester, Massachusetts.

Also, WCBH, University of Mississippi, University Postoffice, Mississippi; KFJM, University of North Dakota, Grand Forks, North Dakota; KOAC, Oregon Agricultural College, Corvallis, Oregon; KFKA, Colorado State Teacher's College, Greeley, Colorado; WGBX, University of Maine, Orono, Maine; KFHA, Western State College of Colorado, Gunnison, Colorado; and KWSC, State College of Washington, Pullman, Washington.

Broadcast Miscellany

A RECENT survey of the field of radio entertainment features reveals the fact that the "Eveready Hour" is the "veteran" of them all in point of regular and continuous service.

This weekly broadcast program first went on the air on December 4, 1923. From that time on, without exception, each week has had its "Eveready Hour," through station WEAF and, since early in 1924, a gradually extending network of stations scattered throughout the East and Middle West. There are contemporary broadcast features which began just about the same time as the "Eveready Hour," but none of these others has had an unbroken run.

The "Eveready Hour," in its earliest days, however, was not the same type of broadcast program that it is to-day. It began, like most other features, as a program of more or less miscellaneous numbers. Slightly less than a year after its début, it began its present type of program which has come to be known as the "continuity" radio program—a sort of radio scenario which tells a story with a combination of music and the spoken word. The first of these "continuity" programs was broadcast on the evening of November 10, 1924. on the eve of Armistice Day and the story was that of America's part in the World War.

CHARLES WOLD AND HIS MUSICAL GLASSES

The glasses are arranged in the manner of a regular musical keyboard. There are 52 perfectly tuned glasses of all sizes and shapes, each of which correspond to the notes of the scale. By moistening his fingertips, the player is able, when striking the glasses, to effect a really sweet tone and has managed to play the most difficult of the more popular classical compositions. He has played from a number of New York broadcasting stations

AT KGW, PORTLAND, OREGON

Herman Kenin's Multnomah Hotel dance orchestra, an excellent organization which plays two programs a week from the Oregon station. Speaking purely as an amateur, the photograph seems to indicate that there are enough musical instruments on deck to supply a couple of other orchestras

TO WHAZ we are indebted for a "Jokeless Minstrel Show." We have heard jokeless minstrels before, but this differed in that jokes were not even attempted. The program was put on by the Delaware and Hudson Railroad Car Shop employees' chorus and orchestra who have been heard before from this station.

LAFF? Why we thought we'd die! At Ford and Glenn (WLS) arguing as to whether or not the windmills on farms are there to cool off the cows. And probably of the whole five minutes' discussion not a single sentence would seem funny in print. Perhaps that's the secret of radio humor?

THE New York Edison hour, which used to be on WJZ is now being heard from WRNY, New York.

ONE of our pet peeves is the practice of multitudinous stations of setting some ham to belaboring the studio organ whenever a lapse occurs in the program. The reason doubtless is

THE CLICQUOT CLUB ESQUIMAUX QUARTET

Heard during the weekly program sponsored by a national advertiser. The Esquimaux are heard through WEAF and a chain of stations every Thursday evening from 9 to 10

that the station is entitled to be on the air at that time and intends to assert that right whether or not for any good cause. The result is inevitably popular music of the rag-time variety, for which, moving picture theaters notwithstanding, the organ was never constructed. A "Hot Mamma" tune played on the organ is not lacking in similarity to a scarf dance as executed by an elephant.

THE ever present jazz vs. "classical music" controversy presents as juicy opportunities for talking a lot and saying nothing as the weighty to-bob-or-not-to-bob problem. Nevertheless the director of WCCO, in a memorandum sent to all those who share in making up the musical programs of the station calling upon them to coöperate in holding down the amount of jazz, managed to make some sage comments on the subject:

"One trouble is that no two people agree as to what constitutes jazz. To one it means all forms of syncopated dance music, although Beethoven knew and used the trick more than a hundred years ago. To another it means rhythm without melody, though Beethoven (again to quote a classic example) put what is practically a kettle drum solo into one of his symphonies. To a third it means clashing dissonances, and yet the person who objects to discords in a dance orchestra would not find any fault with the same sounds in Richard Strauss.

"What we really want to do is to eliminate, so far as possible, the kind of music which is nothing but a riot of noise, in which the melody is so trivial as to be practically not there at all, and in which the dissonances are the result of nothing more than the desire to make a racket. Such music is possible when one is actually dancing, and the noises of the hall help to overcome the sounds of the orchestra, but it is certainly not suitable for broadcasting.

"It must be remembered, however, that the radio audience represents every conceivable variety of tastes, and also that until all the programs are broadcast direct from the studios, and not by remote control, the station cannot exercise complete authority over the music. We are working in the right direction, but we cannot reach the goal as fast as many of our listeners would like."

WOAW celebrated its fourth birthday recently with an ambitious program. A musical-dramatic exposition of the history of the United States (announced as a pageant!) was heard in an eight hours continuous broadcast. Twenty-three episodes involving the outstanding incidents of American history were presented.

WE ARE informed by WTAM that "a new development in programs is being put on Tuesday and Thursday mornings beginning at 8:45 Eastern time for the benefit of public school pupils.

"These programs are planned and worked out by Alice M. Keith of the Music Appreciation Department of the Cleveland Board of Education and were originally planned for Cleveland schools. Schools all over Ohio, Michigan, Illinois, Indiana, Kentucky, and Pennsylvania are recognizing the value of these programs in their school curriculum and the station is receiving many favorable and complimentary reports on the value of the programs to pupils in public schools. The music offered is of the best procurable, given by members of the Cleveland Symphony Orchestra and other artists of the highest talents."

WTAM's transmitting apparatus is now located at Mentor, Ohio, about twenty miles east of Cleveland.

AMONG the best of radio's harmonizers are Correll and Gosden of WLIB and WGN. Their singing of a little ditty having to do with "Who'll be the papa?" is incomparable, and their side remarks are actually funny. After only a few months on the air, they have already been captured by the phonograph record people which, we suppose, constitutes the most tangible tribute a radio minstrel can receive.

PERHAPS the best weekly program on the air during the past spring, certainly the best if time-hallowed reputation is the criterion, was that of the Boston Symphony Orchestra as broadcast by WEEI from Symphony Hall during the regular Saturday night concerts. Unfortunately WEEI doesn't penetrate very far into the hinterlands, so the full value of this noteworthy feature was far from realized. WEEI is on the WEAF circuit and this seems by all odds the best instance where the direction of the circuit might well be inverted—as has been suggested from time to time. We hope that another season will see this program, if it is still made available, extended, westward by wire.

ONLY two or three times have we heard a radio concert by an orchestra composed exclusively of wood-winds. Considering the fact that wood-winds reproduce better, probably, than any other type of instrument they could be well made more use of. A concert by the Bruno Labate Wood-Wind Ensemble recently heard through WJZ proved to be one of the least radioy programs we have ever heard. The illusion of being in the same room with the orchestra was almost complete.

IF YOU like a story with your music, we suggest the series of musical dramas based on famous composers' lives as produced by Mr. Dailey Paskman, director of WGBS. The first of the series was a dramatization of the most interesting moments in the life of Ludwig von Beethoven. It was compiled by Mr. Paskman from a study of the biographies, letters, and music of Beethoven. Several characters were introduced and, of rather more importance, a symphony orchestra played selections from the nine symphonies. Similar dramatizations of the lives of Chopin, Schubert, Wagner, and others are scheduled.

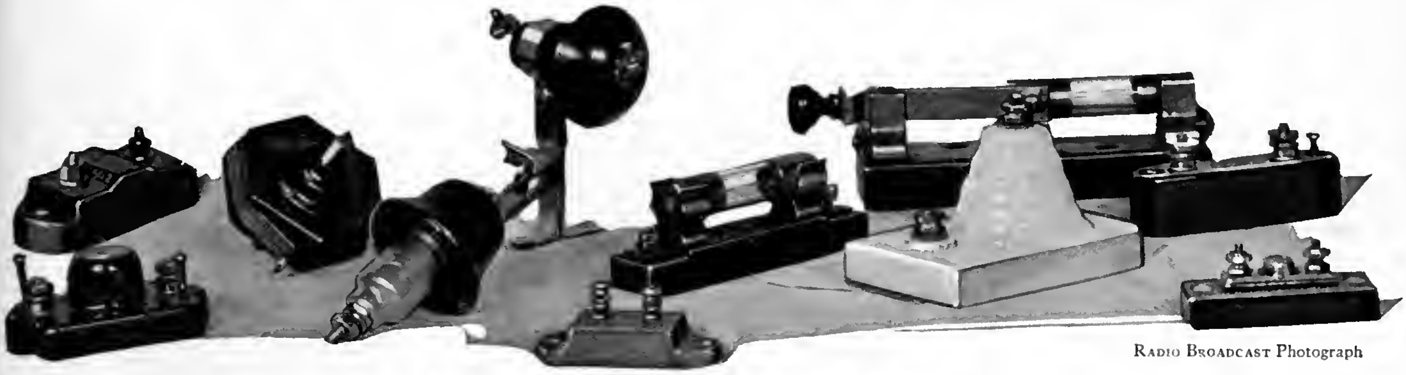
TWO college organizations heard recently through WBZ proved excellent offerings. The Holy Cross College Combined Musical Clubs under the direction of Edward Bouvier was heard in a two-hour program presenting a 60-man chorus, a 40 piece orchestra and a saxophone sextet. The principal song hits and orchestral numbers from the twenty-eighth annual Tech show were heard on another occasion. In previous years WBZ has broadcast this show direct from the stage of the opera house at Boston, but this year secured a special studio performance which, by omitting non-musical stage business, was made more suitable for the air.

FREEMAN F. GOSDEN AND CHARLES J. CORRELL

These grinning subjects are two harmony singers often heard from WLIB and WGN. During the short time they have been on the air, they have established themselves thoroughly

The Lightning Arrester

The Different Types Available—How the Arrester Works, Its Care, and Installation—The Best Ground to Use—The Rules of the National Board of Fire Underwriters



Radio Broadcast Photograph

By H. MELCHIOR BISHOP

PARAPHRASING that famous writer who began his discourse on "Snakes in Ireland" with the flat statement that there are no snakes in Ireland, the author will begin his discussion of "Lightning Arresters" with the declaration that there is no such thing as a lightning arrester. So far, nothing has ever been found which could "arrest" lightning, or even slow it up, because once started, it has that pronounced "go-getter" quality which always succeeds. In the case of lightning, the success is often disastrous to the *n*th degree.

So the term "lightning arrester" is a misnomer. Yet the device called by that name has a very distinct utility in protecting the radio set from injury by lightning. In fact, it protects the entire building, for there is no better lightning rod installation than a properly erected antenna, grounded through a suitable "lightning arrester."

The word "grounded" in the previous sentence, gives us our first real key to the actual action of the lightning arrester. The device is really a condenser of very low capacity which is connected in some suitable manner across the antenna and ground posts of the set and which could be more accurately termed a "protective condenser." It is not, of course, located on the set, but is usually placed at the point where the lead-in enters the building, and preferably on the outside of the building.

Due to the extremely low capacity of the arrester, its tendency to by-pass radio frequency currents is so small as to be negligible, and due to the infinitesimally low voltage of these currents, they cannot possibly jump the air gap. A high voltage, high amperage charge, however, which would be capable of injuring the set, tends to jump the air gap between the terminals of the arrester (this gap is usually about 0.005-inch), and ground itself. Let us see why this is so, and how this operation protects the set and operator from injury by lightning.

To do this, let us first refer to Figs. 1 and 2, which show the principles of construction of the two types of arrester in common use. Fig. 1 shows the air gap type, while Fig. 2 shows the vacuum gap, or vacuum type, as it is often simply called. There are other types of lightning arresters in use, such as the horn gap and saw tooth type, but due to their bulkiness, and to the fact that no circuits of great current-carrying capacity are to be protected, they are rarely used in radio receiving work. Of the two types in general use, there are many variations, and practically all of these are good if properly constructed.

HOW THE ARRESTER WORKS

WE NOW turn to Fig. 3, which shows an air gap type of lightning arrester connected to the radio-frequency input end of a receiver. Suppose a signal to be

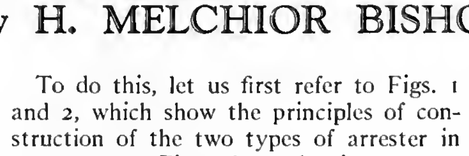


FIG. 1

The air gap arrester. The air gap, G, is about 0.005 inches wide

impressed upon the antenna; the radio-frequency current is too weak and low in voltage to jump across the points which form the gap in the lightning arrester, although these points, as stated above, are usually only about five thousandths (0.005) of an inch apart. The area of these points is so small that their condenser or capacity effect is practically nil, hence there is no path for the signal except that through the antenna coupling coil and thence to ground. The set is therefore actuated by this radio frequency current, and a signal is produced in the telephones or loud speaker, as the case may be. Suppose now that a high potential atmospheric electrical discharge takes place, and is picked up by the antenna. Such discharges are almost always erratic and fluctuating in character, therefore the antenna coil of the set exerts a powerful choking action upon them, even though the inductance of this coil is comparatively very low in value. For this reason, and due also to the high voltage nature of the discharge, the major portion of it tends to jump the short gap in the arrester and ground itself, without causing any more effect on the set than a loud static crash which will possibly drown out the signal for a moment. Though the length of the gap in the vacuum type of lightning arrester is greater, its action is identical due to the fact that the partial vacuum which is maintained in this type reduces the discharge resistance between the points.

"It is all very well," you say, "to drain off ordinary high potential atmospheric electricity in this manner, but what has all this to do with actual lightning protection?" To answer this question, it is necessary to ascertain what lightning is, and what causes it.

Lightning is a discharge of extremely high potential atmospheric electricity, and is really the breaking down of the dielectric of a huge condenser, in which the storm cloud is one plate, the earth the other, and the intervening atmosphere is the dielectric. During, and just before a storm, this charge gradually builds up, never attaining its full potential suddenly. If, then, a grounded conductor projects into the storm cloud, or even, as is the case with most antennas, comes close to it, the effect is to prevent the building up of this charge to the tension necessary to cause a breakdown of the intervening air strata, and hence, that particular spot is rarely, if ever, visited by lightning. The effect, then, of a properly grounded antenna, is that of a lightning rod, but, due to its greater collecting surface, the result obtained is more completely efficient, offering unequalled protection from lightning.

CARE AND INSTALLATION

WHILE the lightning arrester is a very necessary and useful piece of equipment, it may in rare cases be the cause of poor reception, or even actual failure to receive any signals. The fact that a lightning arrester, after months or even years of use, is finally the cause of this type of trouble, does not necessarily prove that the device was faulty, for the following reasons.

In the first place, and especially in the case of the air gap type, repeated discharges across the gap to ground may gradually burn the surface of the points, causing a powder of metallic oxides to form on the burned surfaces. This oxide tends to fall off, and gradually fill the gap, causing a partial or complete short-circuit of the arrester, which in turn causes the radio frequency currents to be erratically by-passed to ground before they reach the set.

In the case of the vacuum gap type, if the vacuum is destroyed by any accident to the arrester, such as the breaking of the cement which seals the gap points into the glass or bakelite tube, the operating resistance of the arrester becomes higher, and the degree of protection is consequently reduced. This defect, however, can fortunately be detected in the average case due to the fact that the terminals will be loose, or the casing cracked.

When installing the lightning arrester, locate it preferably on the outside of the building and near to the window where the lead-in is to be brought in. Then run the lead-in directly down to the arrester in as short and straight a line as is consistant with good appearance, directly to the set. Do not cut the lead-in at the arrester, but wrap it around the terminal of the arrester and bring it in without breaks or joints. This is recognized by radio engineers as the very best practice.

The best type of lightning ground is an iron rod or pipe from four to six feet in length driven into the ground as far as possible, directly below the ground terminal of the lightning arrester. From this terminal, a wire, bare or insulated, but preferably the latter, and at least as heavy as the lead-in wire, is run in a direct line to the ground pipe and fastened securely to it by means of a stoutly constructed ground clamp. The clamp is exposed to the weather and a flimsy one will soon corrode and make poor contact.

If impossible to obtain this type of ground, the next best one is a cold water pipe, located as near as possible to the set and lead-in. A hot water pipe or radiator connection can also be used with very good results, but don't use a gas pipe.

Where it is more convenient to use an inside ground connection, it is necessary for high receiving efficiency to keep the ground lead-in well separated from the antenna lead-in, or to mount the lightning arrester on the interior of the building.

FIRE UNDERWRITERS' RULES

IN THE 1925 issue of the code book of the National Board of Fire Underwriters, some rules are given with regard to the installation of lightning arresters. These regulations are given below, for the aid of the reader, and have been taken from pages 144 and 145 of the code book.

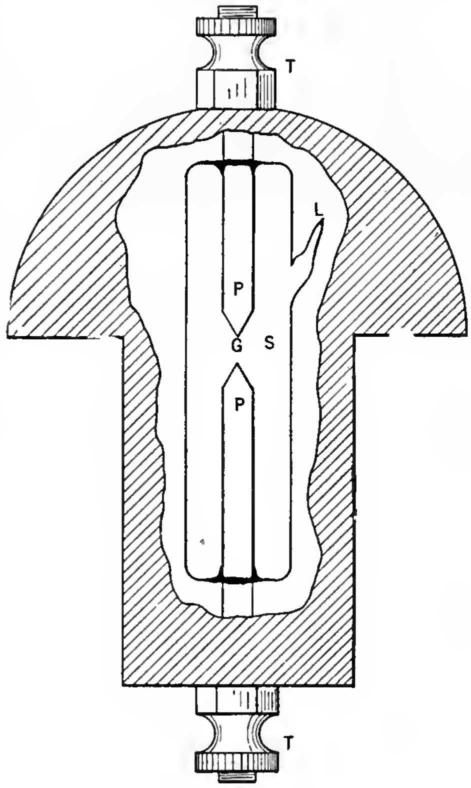


FIG. 2

The vacuum type of arrester. The width of the gap depends upon the degree of vacuum. The inner glass vacuum tube is indicated as S. L is the seal off

1. Each lead-in conductor shall enter the building through a non-combustible, non-absorptive, insulating bushing, slanting upward toward the inside, or by means of an approved device designed to give equivalent protection.
2. Each lead-in conductor shall be provided with an approved protective device (lightning arrester) which will operate at a voltage of 500 volts or less, properly connected and located either inside the building at some point between the entrance and the set which is convenient to a ground, or outside the building as near as practicable to the point of entrance. The protector shall not be placed in the immediate vicinity of easily ignitable stuff, or where exposed to inflammable gases or dust or flyings of combustible materials.
3. If an antenna grounding switch is employed, it shall, in its closed position, form a shunt around the protective device. Such a switch shall not be used as a substitute for the protective device. (Note "S," Fig. 3).

   It is recommended that the antenna grounding switch be employed, and that in addition a switch rated at not less than 30 amperes, 250 volts, be located between the lead-in conductor and the receiving set.
4. The protective grounding conductor may be bare and shall be of copper, bronze, or approved copper-clad steel. The protective grounding conductor shall be not smaller nor have less conductance per unit of length, than the lead-in conductor, and in no case shall be smaller than No. 14 if copper nor smaller than No. 17 if of bronze or copper-clad steel. The protective grounding conductor shall be run in as straight a line as possible from the protective device to a good permanent ground. Preference shall be given to water piping. Other permissible grounds are grounded steel frames of buildings or other grounded metal work in the building, and artificial grounds such as driven pipes, rods, plates, cones, etc. Gas piping shall not be used for the ground.
5. The protective grounding conductor shall be guarded where exposed to mechanical injury. An approved ground clamp shall be used where the protective grounding conductor is connected to pipes or piping.
6. The protective grounding conductor may be run either inside or outside the building. The protective grounding conductor and ground, installed as prescribed in the preceding paragraphs, 4 and 5, may be used as the operating ground.

   It is recommended that in this case, the operating grounding conductor be connected to the ground terminal of the protective device.

   If desired, a separate operating grounding connection and ground may be used, this operating grounding conductor being either bare or provided with an insulated covering.

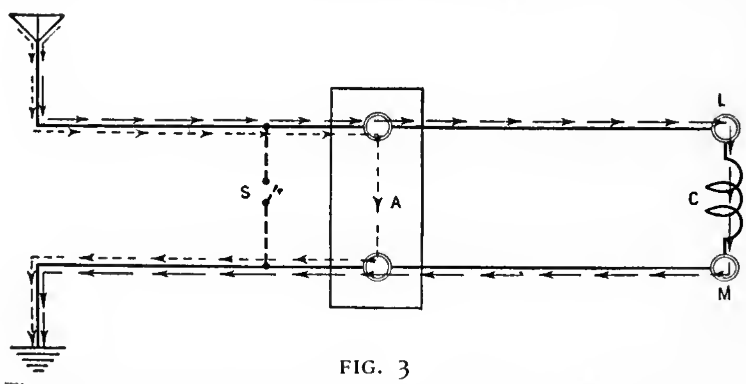
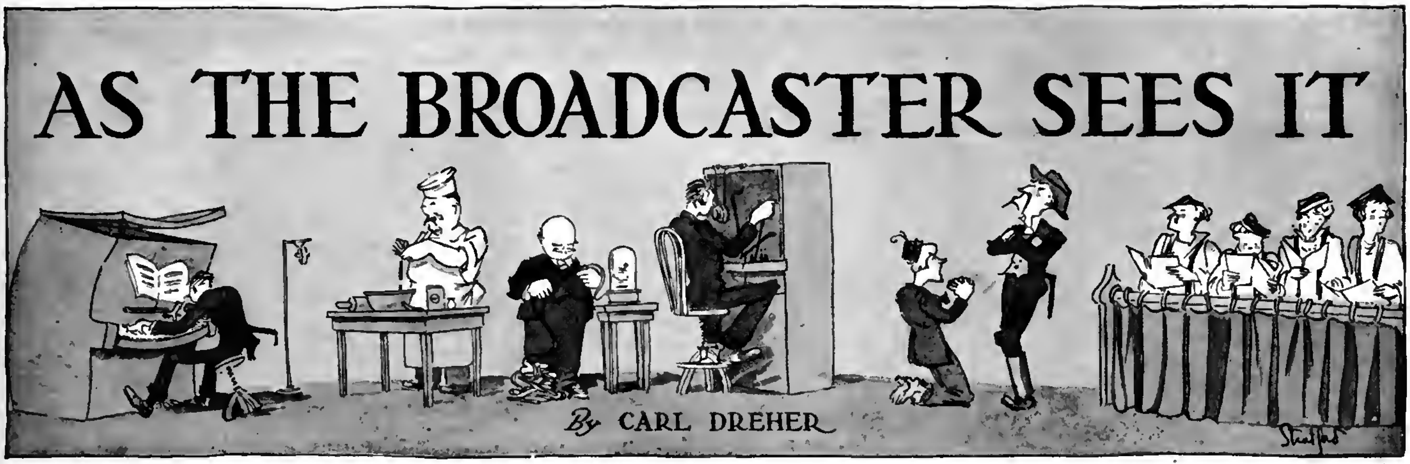


FIG. 3

The correct connections for an arrester. The antenna and ground posts are shown as L and M., while C represents the antenna coil of set. The dotted arrows show the path followed by high potential atmospherics, while the other arrows indicate the course of the incoming signals



Drawings by Stuart Hay

Glaring Faults in Newspaper Radio Journalism

MORE than once, and in various media, I have wrinkled my nose and stuck out my tongue at the gentlemen who uplift radio in the press. The result has been striking. Statistics show that in 1925, when I first became rabid on this subject, three times as many radio editors died as in any previous year. In nether Mozambique so many of them perished that none was left to edit the radio sheets of the country, and a chiropractor had to be called in to perform this duty. In the United States, those who remain at their posts are unable to sleep, eat, or speak courteously to their wives; they look pale and drawn, and 65 per cent. are in the hands of nerve specialists. So low have the radio newspaper supplements fallen in the public estimation, as a result of my campaign, that it is necessary to pay the writers 20 cents a word, and I contemplate contributing to them myself. However, the other day a delegation of the relatives of the unfortunate radio editors called on me to ask wherefore I persecute their loved ones, and whether I would not set them at rest by saying plainly what I had against them. I have therefore decided to devote an article to the subject of radio newspaper supplements, and hereafter to hold my peace on this topic.

Before I go on, I wish to set down a few reservations. I realize that it must be a difficult job to be scholarly and to edit a radio sheet at the same time. Maybe if I went into radio journalism, as an editor, I'd be worse than any of the men now in the high seats of power. This, however, is no reason why I should not speak my mind, by the same theory that permits the radio critics of the metropolitan journals to razz a radio station when a modulator goes soft during a program, although they could not even build a single-circuit regenerative set themselves, much less run a broadcasting plant. Therefore, let me be candid. I think some of the radio sheets are pretty good, considering that they are compelled to be spectacular in order to get readers, that they need advertisers in order to live, and that, through economic ills for which they are not to blame, they find themselves unable to hire $20,000-a-year radio engineers to criticize their stuff before publication. On the other hand, I find in them lapses which any talented amateur could avoid. Let me illustrate.

The quotation below is from a 32-page radio supplement which I shall not name, because it is one of the best of the lot and my selecting it as an example might make it seem, unjustly, as one of the worst. The article is about some set-building celebrity of whom I never heard before, so I have nothing against him. We shall call him Smith. A sample paragraph from the epic of Mr. Smith:

> Popular opinion said it couldn't be done, but he did it just the same! In 1920, Mr. Smith hooked up a De Forest audion to a crystal detector in an attempt to amplify signals received on the crystal alone. Hours of careful thought and planning went into the experiment. Leading amateurs scoffed at the idea. It couldn't be done! But Mr. Smith refused to be daunted. He tried various hook-ups, he experimented for hours. Finally it worked!

Do you recognize the style and method? The three exclamation marks in one short paragraph, the playing up of the scoffed-at-but-undaunted-inventor theme, the triumphant climax. "Finally it worked!" Where have we seen it before? In the green and scarlet Sunday magazine sections of the past two decades, with their illustrated confessions of seduced artist's models, rehashes of the divorce scandals of the rich, spectacular suicides (the arrow marks the point where the woman jumped off the bridge), and entertaining murders. In these sheets, science receives its full measure of attention, sea-serpents wiggle across the pages, hairy gorillas armed with clubs attack explorers, and the skyscrapers of New York are shown crumbling to the ground under the influence of violin notes bowed by a young man with long hair and a determined expression. Some of the masters of English who have been turning out this stuff, moderating their style a little, have turned to radio. The underlying scheme is the same: to make something out of nothing, and to make that something exciting.

But the style is the least objection. The facts are the thing. From the paragraph quoted, you would think that in 1920 the proposal to use a vacuum tube as an audio amplifier was an astounding and unheard of novelty. Now, I am fairly ignorant myself, and offhand I can't say who did it first, or when. But I do know that, either in 1913 or 1914, Mr. E. E. Bucher wrote a series of technical articles for the *Wireless Age*, under the general heading of "How to Conduct a Radio Club." Among other things, Mr. Bucher threw the amateurs of the day into great excitement by printing the technique of using a vacuum tube as an amplifier after a crystal detector. The input transformer was a spark coil, there being as yet no such specialized device as the cute little audio transformers of our generation. The reason I remember the article is that I performed the experiments outlined, using a one-inch spark coil, and got fairly good results. To clinch the matter, refer to the *Proceedings of the Institute of Radio Engineers*, Vol. 3, No. 2, June, 1915, in which Haraden Pratt printed a paper on "Long Range Reception with Combined Crystal Detector and Audion Amplifier." In the discussion, in which Lee De Forest, Alfred N. Goldsmith, J. H. Morecroft, E. F. W. Alexanderson, Roy A. Weagant, and others took part, no one made the slightest mention of the crystal-tube combination as such; it was evidently nothing very startling. It probably dates back to around 1910.

This is no isolated instance. Without looking for them, one cannot help seeing a dozen such blunders in the average newspaper radio section. Another amusing case was a chronology of tube development, in which a commercial company was stated to have sold certain rights, in 1913, for $50,000,000; additional rights, in 1914, for $90,000,000; and a final batch, in 1917, for $250,000,000. The only trouble was that each figure had three zeros too many, the actual sums having been thousands of dollars, not millions. Calculating on this basis, we should all be millionaires. And there was no mistake about it; the figures were printed three times over, in separate paragraphs. Is there no one on that paper who knows the elementary facts in the history of radio? Of course, if you look at the text as simply a means of drawing equally uninformed readers to the advertisements flanking the reading matter, then it's quite all right. But let us hope that not all the men in newspaper radio look at the matter quite so sordidly. If they do, they cannot blame a radio man with respect for his craft for emitting a few roars, as I do now.

Another thing that grieves me in some of the radio sections, is the way in which they allow some mushroom investigator (clothing business till 1917, then Naval Radio School to Electrician 3rd Cl., clothing business again after the war, and reëntered radio in 1922 because it looked like money) to alter a well-known circuit in a few negligible respects, call it by his name, make arrangements with the gyp retailers to recommend parts with which they are overstocked, and persuade innocent office boys and bank presidents to buy the junk and build a wonder set which will be supplanted in a week. I said it irritates me, although in general I eschew indignation, on the theory that it will take three thousand years to reform human nature—far too long to wait. But it does set one's teeth on edge to see these camp-followers of radio attaching their names to inventions over which genuine investigators sweated blood years ago, while the actual inventors are forgotten, or dead, or both.

I write, as I always do in this place, from my personal point of view as an engineer. And is there no balm in Gilead? Very likely there is. I know the arguments—some of the sets described have merit; the supplements contain much material valuable in the education of novices; they facilitate ready adjustment of the retail market, especially in the sale of parts; and all these things must be done in haste, in the nature of newspaper work. All true and admitted, and if some newspaper radio editor wants to write up a good article in defense of the supplements, he is welcome to as much of this department as he needs to present his case. But it seems to me that these objects could be achieved with some regard for technical standards, engineering ethics, and reasonable accuracy in reporting. There must be many newspaper radio writers who would hesitate, even for their bread and butter, to violate the traditions of a decent profession. To those men, I address this article. There is room for improvement, and it is through them that improvement must come.

Radicalism and Radio Broadcasting

SOME months ago the program directors of the great metropolis on the Eastern seaboard, as well as other literate citizens, read with shudders a newspaper report that the radicals were about to establish a broadcasting station, or to buy their way into an existing one, using funds derived from the endowment founded by Mr. Charles Garland. Although I am no braver than other radio men, and stay further away from the 10,000-volt buses than some, I must confess that I scanned the item without a single quiver, except perhaps one of anticipation. The ether, economically and politically, is too much one-way, one-side for my taste. I have a Jeffersonian leaning toward free discussion, and, were I a program director (which God forbid should be added to my existing troubles) with a station where I had a free hand (no such station exists) I fear I should give ten minutes now and then to anarchists, Mormons, birth controllers, and people who say there is no Santa Claus. Alack, I was disappointed. No radical station gripped the ether by the larynx. Maybe they couldn't get a wavelength, maybe Moscow didn't supply the money, maybe they had the money but spent it on the picket line at Paterson, New Jersey, and environs, where the textile strike rages at this writing. Whatever the cause, to date no carrier wave has been modulated in crimson.

However, there was one little spasm during March. Our friend "Pioneer," an eminent New York radio critic, declared himself, one morning, as follows:

> The perversity of the radio impresarios is infallible and astounding. Just when we detect symptoms of an universal conservatism among the metropolitan program arrangers, a dumfounding piece of exuberance such as the publicity release below bursts in on us:
>
> "Having been pulled off many soap-boxes and run faster than many bluecoats, the radical leaders have at last found a place where they can expound their theories without even an umbrella being broken over their heads. In honor of Karl Marx' birthday, March 12, WRNY has turned novelty night period over to the radical leaders of New York and they have been promised they can go as far as they like and, whether or not you agree with them, it promises to be a red hot hour."
>
> Possibly WRNY regards radicalism as a huge joke, capable of stirring uproarious mirth in all listening bosoms. Possibly WRNY cherishes the belief that all radio listeners tune-in promptly at the beginning of every program and stay to the end, thus hearing all the explanatory announcements made by the station. Possibly WRNY labors with the delusion that a listener always takes what comes out of the loud speaker in the same spirit that prevails in the studio.
>
> Possibly WRNY has evolved a system whereby utterances barred under the sedition and treason definitions are neither seditious nor treasonable. Or possibly WRNY is going to pull a program "dud" after the advance publicity explosion. Any way you look at it, WRNY seems to have let its pursuit of novelty carry it into a not-nice position.

The advance-censure of the estimable "Pioneer" had its effect. Or possibly it was something else. At any rate, Mr. Gernsback's 258-meter radiation remained pure and undefiled. The radical hour was cancelled.

Unable to listen myself, I had my agents

"IN MOZAMBIQUE SO MANY PERISHED THAT NONE WAS LEFT TO EDIT THE RADIO SHEETS OF THE COUNTRY" planted on the wavelength, their ears in the loud speaker, waiting with sharpened pencils for whatever might betide. What I wanted to know particularly was who the radical leaders of New York were. I have never been able to find out. The fact is that they do not agree among themselves on that point, which is one reason why the Republic stands.

For one, however, I rise in meeting and state candidly that I resent the solicitude of the Monsieur Pioneer in my behalf. I dislike pap, in books, newspapers, or on the air. I have heard on the air an enormous amount of extreme conservatism, and it has not hurt me. The radicals, I am confident, would not have hurt me either. If they are seditious, let them be thrown into the hoosegow. But first let them be seditious.

When the radical brethren cry that the country is run from the corner of Wall and Broad Streets, I stroke my chin. Maybe they're right. But what the radicals must next show me, before I clasp them to my bosom, is that they can run the show, if it be handed over to them, as well as the predatori aforementioned. This I doubt. I doubt, also, that if the Red gentlemen had been allowed by WRNY and "Pioneer" to have their say, their arguments would have convinced me on this salient point. And I doubt some more that, had they convinced me, I should immediately have heaved a bomb across the street at the château of Mr. Charles M. Schwab, murdered the traffic cop on the corner, and sent Dr. Nicholas Murray Butler a cigar box full of tarantulas. My belief is that if I had been allowed to listen, I should have yawned, gone to bed, and resumed my wage slavery docilely the following morning. As for the listeners not blessed with my astounding sapience, I believe they would not have attended to the radical menace at all. Rather, their ears would have been attuned to some radio vaudeville nearer their hearts.

Technical Operation of Broadcasting Stations

7. *Modulation*

IN PRESENTING the seventh article in the "Technical Operation" series, and the eleventh technical discussion since we began printing a department for and by broadcasters, a few words of explanation may be tolerated. This is a hand-to-mouth series. The titles have no especial order and are picked from month to month largely in response to requests from other broadcasters to this broadcaster who happens to be writing the articles. Our object is to be of immediate service to technicians in a relatively new field by clearing up points which are causing trouble. Later we may undertake a more complete and formal treatment of the subject of broadcast station design and operation, but the present task is more urgent. We shall continue it while our correspondence indicates a need for it. Suggestions and inquiries are most welcome. And if you disagree with what is said, or have something to add, let us have that. The writer does not pretend to be always right or to know it all.

In response to requests we print a list of the previous titles and the issues in which they appeared:

Microphone Placing in Studios — September, 1925
Outdoor Symphonic Pick-Up — October, 1925
Personnel and Organization in Broadcasting — November, 1925
Technical Routine in Broadcasting Stations
1. *Wire Lines* — December, 1925
Studio Microphone Placing—Further Consideration — January, 1926
Technical Routine in Broadcasting Stations
2. *Control Work* — February, 1926
3. *Monitoring* — March, 1926
4. *Multiple Pick-Up* — April, 1926
5. *Equalization* — May, 1926
6. *Types of Equalizers* — June, 1926

This month we shall devote the space to the topic of "Modulation,"—how it is done and the moot question of how much it should be done.

Modulation is the process of moulding the carrier oscillations of a telephone station in accordance with the acoustic vibrations which are to be reproduced, ultimately, at the receiving end. Probably the most effective method as yet developed is that disclosed by R. A. Heising of the Western Electric Company, before the Institute of Radio Engineers, on December 1, 1920, and described in Heising's paper on "Modulation in Radio Telephony," in the August, 1921, issue of the *I. R. E. Proceedings*. This is popularly known as the Heising or constant-current method of plate modulation. A lot of water has flowed under the radio bridges since 1920, and some of the statements in Mr. Heising's classical paper would have to be revised in this day of broadcasting. For example, he said of the condition where K, the modulation constant, is less than unity (per centage modulation less than 100 per cent.): "Such a condition is very undesirable. It wastes power. . . . We should . . . always use radio systems which will give complete modulation." Well enough for the radio telephony of 1920, dealing with commercial speech requirements only, but the high quality musical radio telephony of 1926 requires gentler treatment. When a decent broadcasting station modulates 100 per cent., it is by accident, and the transmitter operators go out and commit hari-kari. But more of this later. The Heising method itself remains the same, and is used in almost all the large broadcasting stations of Great Britain and the United States.

Fig. 1 shows how it works. The large iron core inductance C, known variously as the Heising, voice, speech, constant current, control, or modulation choke, is the solar plexus of the diagram. It will be noticed that both the oscillator tube or tubes O, and the modulators M, receive their plate supply through this impedance coil. The effect of the choke, as the term designates, is to block current variations and to keep the total plate current of the oscillator and modulator banks constant. But obviously the microphone MIC, impressing audio potentials corresponding to speech or musical input on the grid of the modulator tube M (in practice this is done through a suitable number of stages of audio amplification, not directly as shown in the schematic diagram of Fig. 1) will result in large variations in the plate current of M. Since, therefore, the current

"THE RADICALS HAVE AT LAST FOUND A PLACE WHERE THEY CAN EXPOUND THEIR THEORIES" through the main or common ammeter (1) remains sensibly constant, while that of the ammeter (2) in the modulator branch varies at audio frequency, the current through the ammeter (3) in the oscillator branch must vary correspondingly, as an inverted image of the modulating currents. (D. C. ammeters in these leads will show a constant reading, which is the *mean* plate current; only an oscillograph could follow the audio-frequency variations.) The last variation continuously affects the amplitude of the carrier. Thus the carrier, which when blank, or unmodulated, appears as in Fig. 2, is narrowed and widened according to a modulation "envelope," as in Fig. 3. This envelope is the audio variation which it is desired to impress on the carrier, and which will be reproduced after rectification or demodulation in the receiver.

It may be shown mathematically that the power content of a completely modulated wave is $\frac{3}{2}$ the power content of an unmodulated wave of the same average current. Inasmuch as complete modulation is not now attempted in broadcasting, except in a few stations whose owners and operators should be delivered over to the public hangman, we may say that practically modulation by the Heising method leaves the antenna power about the same as when the carrier is left blank. Roughly, the energy added to the carrier by the modulators, when their plate current drops, is equal to the energy of which the modulators rob the oscillators in the next half of the cycle, and the average radio-frequency power remains practically unchanged. This point has been much disputed, but its interest is largely theoretical.

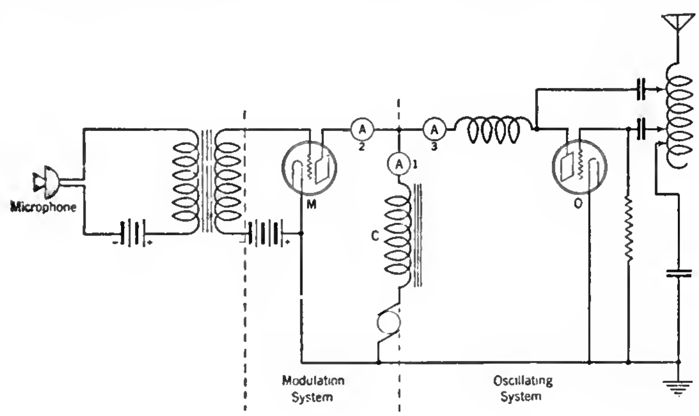


FIG. 1

Several precautions must be taken in this method of choke telephone control if distortion is to be avoided, but at least serious distortion is not inherent in the method, as in most of the other schemes which have been proposed. Thus the duplication (or worse) of valves is justified.

One requirement which is so frequently neglected that it must be mentioned here, although these articles deal with operation rather than design, is that the total power taken by the modulators should at least equal the power taken by the oscillators.

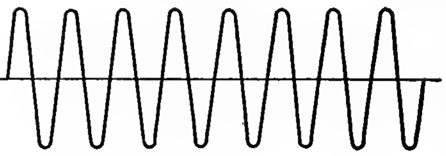


FIG. 2

Unless the set is constructed on this principle, the depth of modulation is very limited, if decent quality is to be preserved, or, if an attempt is made to modulate higher, there will be severe distortion on peaks. Many transmitters are built with an equal number of oscillators and modulators—often two of each. If the same type of tube is used for the two functions, such a combination cannot be modulated by the Heising method over about 35 per cent. without distortion. Above this value, the grids of the modulators swing positive, drawing current, all the load conditions leading up to the oscillators change on peaks, and distortion is inevitable.

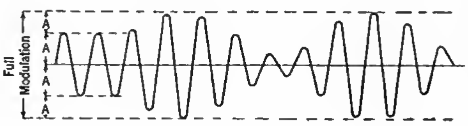


FIG. 3

If the same type of tube is used for oscillation and control, a good rule is to allow two modulators per one oscillator. Even this does not satisfy the equal power requirement, for, used as an oscillation generator, a tube will normally draw three or four times the power it will take as a modulator. The reason for this is that an oscillator is merely a converter of energy and gets rid of over half its input, swinging all over its characteristic curve and drawing grid current freely as it does so, while a modulator should not be allowed to draw grid current, and must not stray too far off the linear portion of its curve. Kellogg ("Design of Non-Distorting Power Amplifiers," by E. W. Kellogg, *Journal of the A. I. E. E.*, May, 1925), points out that the power rating of a given tube as an amplifier, for these reasons, is only of the order of one-tenth its rating as an oscillator. And a modulator is a special sort of amplifier. Kellogg also says, in a very brief treatment of the subject of modulation, in the same paper, "If the same design of tube is used for modulator as for oscillator, it will generally be found that several modulator tubes should be employed for each oscillator tube, in order to take care of the peak voltages without exceeding the straight line range of the modulators. Failure to provide adequate modulator capacity is a frequent cause of distortion in radio transmitters."

The constant-current choke requires an inductance of the order of 100 henrys, in order to avoid loss of the low speech and music frequencies, and the capacity should be low to preserve the high frequencies. The situation here is the same as in the design of small audio transformers and chokes for receiving sets.

Assuming sufficient modulator capacity to obviate modulator grid current and rectification, and proper design of the control choke, and other parts, the question next arises as to how modulation shall be checked and how high it should be allowed to go.

The listening check is the most common as well as the most fundamental. The transmitter operator monitors on a receiving set and modulates as high as he can without injuring quality as far as he can judge. The rub is in the qualifying phrase. Not every "radiotrician" has a sharp ear for distortion, and even if he starts with this qualification at the beginning of a program, after four or five hours of listening it will probably take a dog fight to arouse him. Thus, while the audio check is indispensable, visual aids are desirable.

Fig. 4 shows one, the simple modulator grid milliammeter; Fig. 5, another, the modulation meter; Fig. 6, a third, the oscillograph. Which you use depends largely on how much money you have to spend. The grid meter, costing only a few dollars, should always be used. If cash is plentiful, all three will come in handy.

On a 1 kw. set, the modulator grid milliammeter will have about a 0–10 milliamperes scale. It should be provided with a short-circuiting switch in case it burns out. In operation the modulation may be run up so that, on the highest peaks, this meter "kicks" one or two mils It

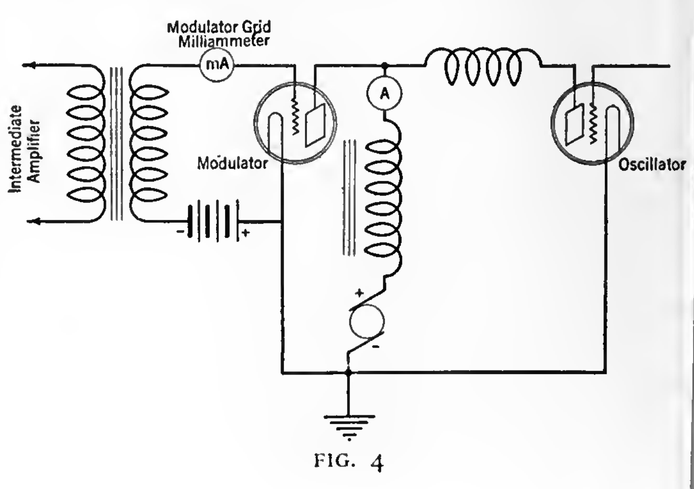


FIG. 4

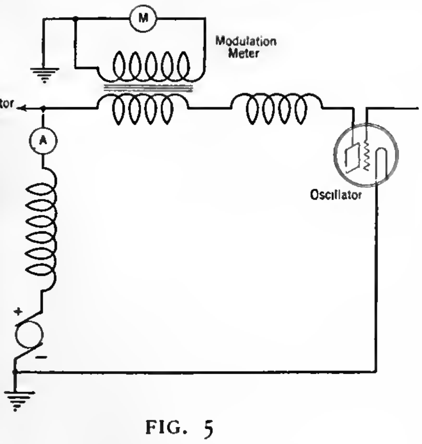


FIG. 5

should never be allowed to show a constant deflection, and most of the time the needle should rest against the zero stop.

A modulation meter is simply an a. c. ammeter connected through a current transformer in the oscillator plate feed so that it will register the audio variations therein, and calibrated in terms of percentage modulation. The full scale value is largely a matter of convenience, depending on the current transformer and other alterable factors; 0–1 ampere is the size in the case of some very large telephone transmitters. The scale is uneven, crowded at the lower end and expanding at the upper, as in all a. c. meters, and marked in percentages from 10 or 15, below which point it is unreadable, to 100. Such meters give only an approximate indication. The inertia and damping of the moving element necessarily play a great part in the response of the meter. Even if the instrument is accurately calibrated, reading it is a matter of skill and guesswork, for the needle bobs around, only rarely holding a definite position for a sustained note.

The most accurate and reliable means of observing percentage modulation is the oscillograph—but you can't get one for less than $500 or so. If you have the capital, it is a good investment. As shown in Fig. 6, the instrument consists essentially of a stretched conducting fibre in a strong d. c. magnetic field. The stretched fibre has a very low natural period and responds indifferently to the various audio frequencies which it gets from the radiating antenna after rectification. A minute mirror cemented to the vibrator strip, as it is called, reflects a beam of light and reproduces a visual image of the modulation on a revolving, four-sided prismatic mirror. On this mirror, when the carrier is blank, one sees an undeviating line of light, which is broken up into a wavy stream when the carrier is modulated. The width of the carrier representation is readily marked on the instrument, and the extent to which the light vibrations approach this reference line indicates the percentage of modulation. An average observer can read the value to between 5 and 10 per cent. without difficulty.

And, once we have means of measuring the degree of modulation, how high shall we let it go? Assuming that the design of the set is such that full modulation may be reached without distortion, my recommendation is 80 per cent. for the highest peaks. This gives a 20 per cent. margin against overmodulation, an average modulation of 40 per cent. (roughly, average modulation is half of the peak values) while on pianissimo passages, the figure will rarely drop below 5 per cent. and there will still be some signal left for the dear listeners. High modulation is desirable, because the strength of the received signal depends not only on the carrier amplitude, as measured by the radio frequency amperage in the antenna, but the degree of change of this amplitude. Also, the carrier as such is an amplifying agency, and to let it go out undermodulated amounts to amplifying disturbances against one's own signal. On the other hand, overmodulation is ruinous, and a reasonable margin must be maintained against it. 80 per cent. top peaks is my compromise, for general conditions. If you don't know the soprano, even that may be cut down somewhat. Raise it at your own risk.

Memoirs of a Radio Engineer, XIII

THE next momentous event in this development was the founding in 1915 of the City College Radio Club, an organization which, I understand, still flourishes. By this time, I was a sophomore at the College of the City of New York, studying various branches of physics under Doctor Goldsmith and other teachers, and still much interested in "wireless." Of course I was not the only amateur at the College, and most of us knew each other and discussed the problems of reception and transmission during our off-hours. We then conceived the idea of forming a radio club. Our resources, however, were almost nil. As usual, therefore, everything depended on Doctor Goldsmith. The Physics Department had a first-rate radio laboratory, which he directed, and he was known to have a generous disposition. We therefore approached the Doctor, outlined our project, and asked for his help, without which it was clear we could not proceed. This assurance he gave us, and we went ahead, putting up a notice on all the Physics bulletin boards that a radio society was in process of formation, and that Doctor Goldsmith would be the Faculty Advisor. Interpreted, this meant that he would be the "angel" of the concern, with the privilege of donating the advice, rotary spark gaps, and quarter-kilowatt transformers for which we longed. Immediately the flies were buzzing around the honey, and we started with twenty members or so, besides some younger boys from Townsend Harris Hall, the preparatory school, who were admitted and patronized in an associate capacity. The founders of this brotherhood, as I recollect, were Edward T. Dickey, Joseph D. R. Freed, Herbert Kayser, Maurice Buchbinder, Jesse Marsten, and I.

Contrary to the experience of most college clubs, this one flourished, without financial difficulties or schisms. Freed was president, Buchbinder officiated as treasurer, I was chairman of the technical committee (which had charge of the apparatus) and chief operator, and the other fellows were officers also—I think Dickey was vice-president and Kayser secretary; at any rate, all the founders were officers and each got his share of the glory. Everybody worked together beautifully. I have said there were no financial difficulties. This was for the same reason that the Rockefeller Institute has no financial difficulties. Doctor Goldsmith presented us with a judiciously picked array of apparatus, including Leyden jars, transformers up to a half-kilowatt rating, quenched and rotary gaps, tuning helices for the transmitter, keys, and all other accessories, tuning coils, condensers, and loose couplers for receiving sets, an omnigraph and automatic tape transmitter for code practice, and numerous other equipment which need not be itemized. Part of it was loaned by the Physics Department, being no longer required in the laboratory work of the division, and much of it was the personal property of Professor Goldsmith. Compared to other radio clubs, we rolled in wealth. At the same time the Doctor took care not to spoil us. We wired up and constructed a great deal of equipment ourselves, such as tables for code practice and a long-wave receiver, held code practice sessions several times a week, and ran off technical meetings at which the members presented papers. When he could find time, Doctor Goldsmith would lecture to us on some aspect of radio engineering, and, as I have remarked before in these articles, it was here, at the Radio Club and, necessarily to a greater extent, in the Laboratory, that no negligible part of the radio engineering of to-day originated, about ten years ago.

(*To be continued*)

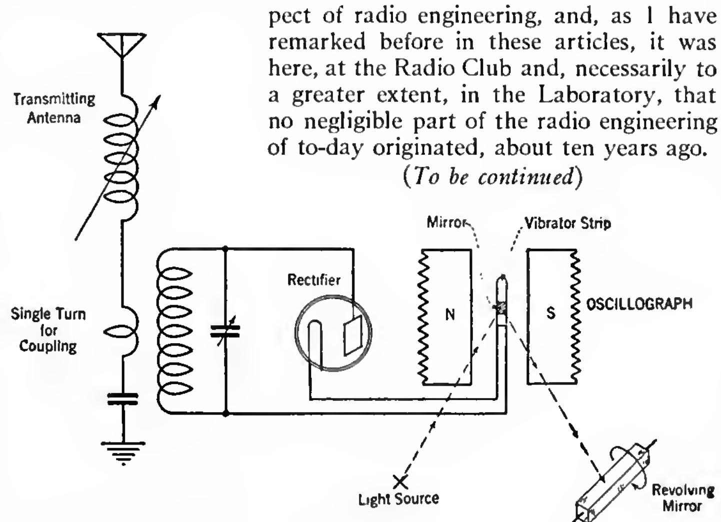


FIG. 6

Tendencies in Modern Receiver Design

A Paper Delivered Before the Radio Club of America in Which Interesting Data Relative to R. F. Amplification, Audio Amplification, Etc., Are Given—Power From the Electric Light Lines

By JULIUS G. ACEVES

Research Assistant to Prof. M. I. Pupin

IF WE look back into the history of radio sets, we will remember that it was not very long ago when the only available matter to be received was radio telegraphy, or "code," which came to us as a rule in the form of short and long musical tones usually of a pitch close to high "C", or about 1000 cycles frequency. To be sure, there were some sixty-cycle operated spark transmitters emitting lower tones, but their harmonics were the sounds that were usually heard in the telephones.

In order to accomplish the reception of "code," a rather simple hook-up was used, but when vacuum tubes came into use, and the regenerative detector became more or less understood, the number of controls increased to such a point that playing on the Wanamaker five-manual organ with its two hundred and twenty-five stops, became easy in comparison with the manipulation of some of the old-time sets for DX work.

With the radiophone started the tremendous development in radio with which we are dealing. The same instruments formerly used for telegraphy were now employed for listening to speech and music, with the same audio-frequency transformers that passed only about two octaves in the scale; yet many radio fans thought that the quality was quite close to the original.

It is our present purpose to review briefly how matters have changed since those days, and what we may expect in the future.

In order to do this in a systematic order, let us follow the developments from various standpoints, namely: technical, acoustical, and operative. Let us study: (a) the radio-frequency amplifier; (b) the detector; (c) the audio-frequency amplifier; (d) the translating device, or loud speaker; and (e) the source of power.

From a technical point of view, after the vacuum tube appeared, the discovery of regeneration by Armstrong was the first landmark in the history of modern radio. As we are supposed to be well acquainted with the mathematics and physics of this phenomenon, we will only touch on the subject lightly here insofar as the quality of reproduction may be affected by regeneration when we deal with this phase of reception. Many investigators found regeneration very readily in radio-frequency amplifiers, but nobody was able to eliminate it from them without also eliminating the amplification, and the next step of importance was the discovery of a means of neutralizing or balancing, the omnipresent regeneration wherever tubes were used, and particularly at high frequencies. Dr. L. A. Hazeltine developed the Neutrodyne, a receiver which has become very popular during the last two or three years on account of its non-radiating properties, and because it is easily tuned.

From these two forms of radio-frequency amplification the regenerative and neutralized forms, numerous combinations soon appeared, the most popular and simple being the Roberts, Browning-Drake, and other similar circuits.

During the War, a great step was taken to do away with the difficulties presented by regeneration in high-frequency amplifiers. As is well known, the cause of regeneration and oscillations in a high-frequency amplifier is the internal coupling in the tubes themselves, even if all the external sources of back coupling are eliminated. This is principally due to the capacity between the grid and the plate, which tends to introduce an effective resistance and an effective reactance in the grid circuit, depending upon the nature of the plate impedance. As a rule, the resistance is negative and therefore if it overcomes the positive effective resistance of the grid circuit, oscillations will immediately be set up. Inasmuch as capacitive couplings are more effective as the frequency becomes higher, it was very difficult to construct amplifiers for frequencies much higher than a few hundred kilocycles. Here we find a very good way of crossing the bridge—by jumping across. If we can't use high-frequency amplifiers, let us not use high-frequencies; rather, let us convert those high frequencies into lower ones that we can handle. The invention of the super-heterodyne by Armstrong was the result.

There are three classes to which most radio sets may belong: (1) The regenerative detector; (2) The neutralized radio-frequency amplifier with or without regeneration; and (3) The double detection or super-heterodyne types, which we shall take up each in its turn.

RADIO-FREQUENCY AMPLIFICATION

IN ORDER to avoid distortion before the detector, it is necessary that the radio-frequency amplification should be equal for all the frequencies within the transmitted band. This band is usually ten kilocycles wide for good articulation and for the highest notes in music, not including their overtones. These latter are, as a matter of fact, inaudible to many people when they exceed five kilocycles, and are rather unimportant for people who can hear them since frequencies above five kilocycles are overtones to high pitches. In many organs, the reed stops, such as the trumpets and oboes, extend to about one octave below the top note, and the last octave is made of flue pipes that have very much weaker overtones than reeds. If, however, the frequency band is reduced to much less than five kilocycles on either side of the carrier, the articulation becomes defective and the voice sounds nasal and the music dull and drummy. This is precisely what happens when regeneration is pushed beyond a certain limit in order either to reach greater distance or to increase the selectivity. Here the multi-stage tuned amplifier comes in for additional selectivity without sacrificing unduly the side bands. It has been shown that a number of tuned stages in concatenation approach the effect of a band filter which would pass with practically the same amplitude, all the components of the band. The filter which would represent a multi-stage amplifier is represented in Fig. 1. The ideal band filter should not contain resistance elements in any part of the circuit if it must show the characteristics of the filter shown in Fig. 2, namely, a square top; but if the sharpness is not carried too far, a good practical compromise may be reached, and characteristics such as shown in Fig. 3 may be obtained. When regeneration is introduced in an amplifier of this sort, it is possible to vary the shape of the characteristics from curve A, Fig. 3, to curve E, according to the amount of feed-back, so that for distant stations the selectivity and sensitivity may be increased although the reproduction may be somewhat impaired. In multi-stage neutralized amplifiers, the sharpness of the tuning increases with the number of stages up to three or four· beyond this number the selectivity does not increase at the same rate. The filter shown in Fig. 1 exhibits the same characteristics.

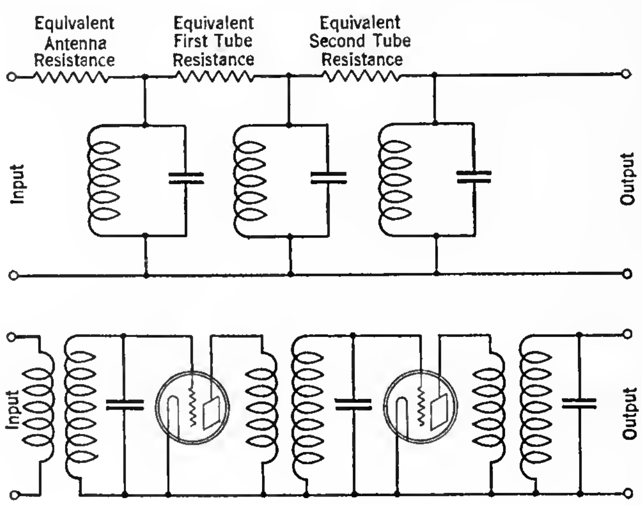
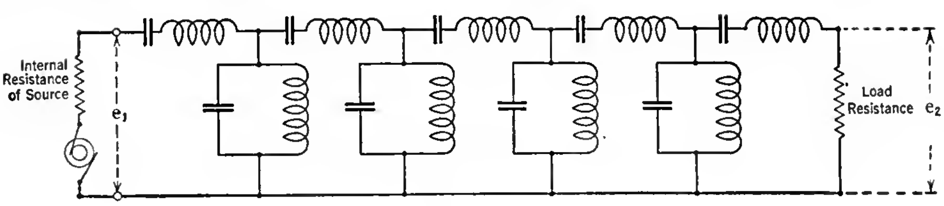


FIG. 1

SUPER-HETERODYNE RECEIVERS

NOW we come to the double detection or super-heterodyne receiver. It has been shown, both mathematically and experimentally, that as a result of the action of the local frequency with the incoming signal wave, the resultant lower frequency wave keeps exactly the same modulating envelope that the original carrier contained, and this is the same as stating that the first detection does not follow the square law, but a linear detection is obtained. Consequently, if the intermediate-frequency amplifier does not discriminate against frequency, the detector would receive a carrier modulated exactly the same as the original but of a lower frequency, and there would have been no inherent distortion introduced by the double detection or frequency conversion system. This holds, of



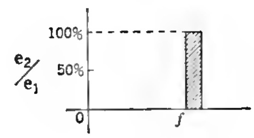


FIG. 2

course, within certain limits of intensity of signal, and local source. It follows that if there is any distortion in a super-heterodyne, it comes from the properties of the intermediate-frequency amplifier and the filters attached to it.

If a band filter, of the type shown in Fig. 2, is introduced between the first detector and the intermediate-frequency amplifier, and the frequency of the local source is so adjusted that the resultant beat frequency band comes exactly over the shaded area, the reproduction would be as good as if no filter were inserted, but the selectivity would be very

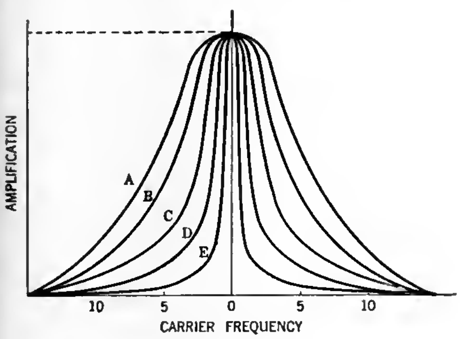


FIG. 3

great, in fact as great as it may be desired by properly constructing the filter. With this system there would be only one other band of frequencies that would pass through, and that is the corresponding band to a station having a frequency greater or less than that to which the receiver is adjusted by double the amount of the intermediate frequency. For that reason, all super-heterodynes have two points in the second dial for every station. As a rule, the undesired band is eliminated by tuning the loop, or input circuit, but this is not anywhere near as effective as the elimination due to the band filter, and for that reason I have suggested the use of a rejector in the input circuit that would short-circuit almost completely the undesired band. This contraption may be in the form of a series coil and condenser

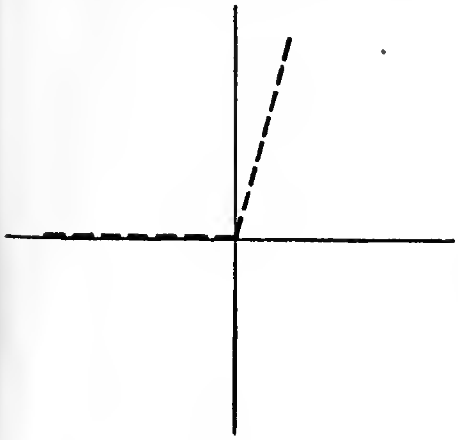


FIG 7

from the grid to the filament of the first detector or inductively coupled to the loop, as shown in Figs. 4 and 5. The same dial that controls the tuning of the loop may be made to control the variable condenser of the rejector, and thereby simplify the operation of the set. It must be borne in mind that the local oscillator should give a pure sine wave. Otherwise some of its harmonics may heterodyne with some other station whose frequency may give beats of the frequency of the band filter, and therefore will not be excluded as they should be.

Having examined the three principal types of radio-frequency amplifiers from a standpoint of good reproduction, let us see how they stand for simplicity of operation.

Unquestionably, the regenerative detector is the simplest receiver to tune if it is properly constructed, and providing a sufficiently long antenna is used so that the coupling between it and the tuned grid circuit may be made as weak as

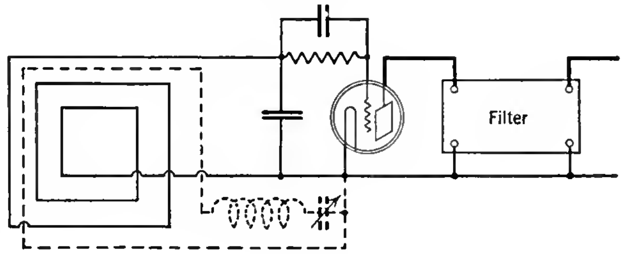


FIG. 5

possible to obtain a fair degree of selectivity with a single tuned circuit.

For local stations only, a very simple set may be made in accordance with Fig. 6, which will have the minimum of control dials, namely, one for selecting the station and another for volume control. If the circuit is in the hands of an intelligent operator, it will never "squeal."

Then comes the type of tuned multi-stage amplifiers in which no attempt is made to neutralize automatically the inherent regeneration. Here we may have a very great amount of distortion if the set is not properly tuned, and also if the regeneration is pushed to the limit. In the hands of inexperienced people, the tuning of several dials, and the control of the so-called "stabilizer", may produce very poor results. To obviate the difficulty, some sets have the "stabilizer" permanently adjusted, and the tuning operations become as simple as when handling a neutrodyne. However, the higher frequencies will be amplified more than the lower ones because the capacitive regeneration of the tubes increases with the frequency.

In order to simplify the tuning, both neutrodynes and tuned radio frequency sets are now being made so that the various tuning condensers may be operated by means of a single dial. If the various parts are made mechanically perfect within a reasonable cost of manufacture, there should be no need of auxiliary dials to correct the deviations, except in the antenna circuit where the reaction of the antenna on the first tuned circuit may be quite appreciable if the optimum coupling is used. A compromise may be reached by slightly sacrificing the sensitivity by reducing the coupling of the antenna to a point where the reaction is hardly appreciable. Also, the condenser that tunes

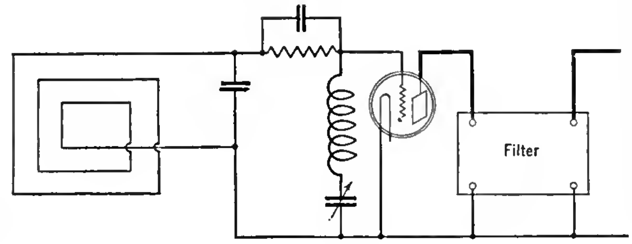


FIG. 4

the first tube and the antenna may be controlled by a separate dial, and the rest of them by a single dial. In order to control the amplification without resorting to dimming of the filaments, a variable inductive coupling from the antenna to the first input tuned circuit may be used, as in Fig. 6, where two coils at right angles are mounted on the shaft of the volume control dial or knob; one of these is connected to the antenna and the other one to a condenser having a capacity equivalent to that of the antenna. In this manner, the reaction of the antenna on the tuned circuit remains almost independent of the position of the volume control knob. The other tuned circuits of the multi-stage amplifier may be provided with coils similar to the first one, with condensers across them, so that an equivalent reaction may be introduced in the other tuned circuits, and all of them controlled from a single dial.

The super-heterodyne type of receiver comes next to the regenerative detector in simplicity of operation. There are only two dials to adjust, and then, if the parts are mechanically accurate and straight line frequency condensers are used, it is possible to control the tuning of

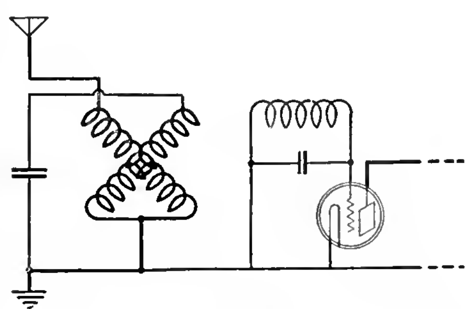


FIG. 6

the loop, or input coil, and the local oscillator by means of a single dial. As we said before, a rejector circuit may also be tuned by the same dial to eliminate the second frequency band, and this would bring us to the ideal receiver from a point of view of simplicity of manipulation and of the greatest distance range and highest degree of selectivity. With a band

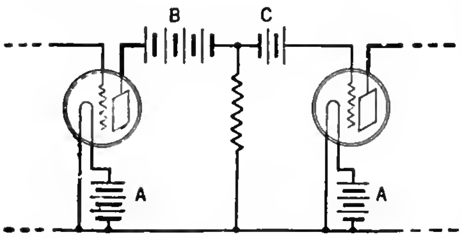


FIG. 8

filter of the type shown in Fig. 2, we would get a modulated carrier wave at the grid of the second detector as near as possible to the original.

DETECTORS

ONE of the elements that is quite often overlooked in a radio receiver is the detector. As a vacuum tube has a non-linear characteristic. it follows that every tube detects to some extent; even the audio-frequency tubes detect to a very small degree. In order, therefore, to make a tube detect, it is necessary to obtain a non-linear relation between the input voltage and the plate current either directly or indirectly. It is done directly when a very strong negative bias is applied to the grid so that the grid-voltage-plate-current characteristic at that point will bend considerably toward the voltage axis. The indirect method consists in utilizing the grid-voltage-grid-current curve which is considerably sharper than the former characteristic. To this end, a small condenser, with a high resistance leak in shunt with it, is interposed in the grid circuit so that when the grid takes current there will be a potential difference across the condenser, and this voltage will act upon the plate current following the grid-voltage-plate-current curve.

This latter method is used to a very much greater extent in radio receivers than the former, and it will not be entirely out of place to say something concerning the values of the bias voltage condenser and leak to be used.

The positive bias makes very little difference as a rule in the efficiency of the detector when strong signals are received, but for very faint

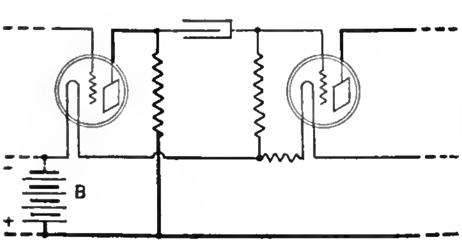


FIG. 9

ones it is best at a value close to the voltage of the A battery. In a recent paper before the I. R. E., a very good discussion on this subject was completely presented, and curves for various types of tubes were shown. Apparently the WD-12 is the most efficient detector with a grid bias of one volt.

The size of the condenser is fixed by the highest audio frequency to be detected, and by the value of the leak. The product RC gives the time constant of discharge of the condenser and leak, and should be smaller than the duration of a cycle for the highest audio frequency. On the other hand, the condenser should be larger than the grid to filament capacity of the tube so that the available signal voltage may not be reduced by the drop across the condenser.

The leak should have as high resistance as possible compatible with the condition above named about the product RC. This holds on the assumption that the tube has no internal leakage, that is, no gas. For strong signals, it may be better to use a lower resistance leak to avoid "blocking," and to flatten somewhat the detecting characteristic so that detected signals may not suffer distortion. An ideal detector should have a curve approaching the line of Fig. 7 so that there may be perfect rectification and linear detection. As much as the detection characteristic will approach this ideal, there will be more efficient detection and less distortion that is, the audio-frequency current will resemble the envelope of the carrier more closely. Crystal detectors are noted for their non-distorting properties, but unfortunately the great majority of them are not uniform and do not stay constant.

Now that we have glanced over the various

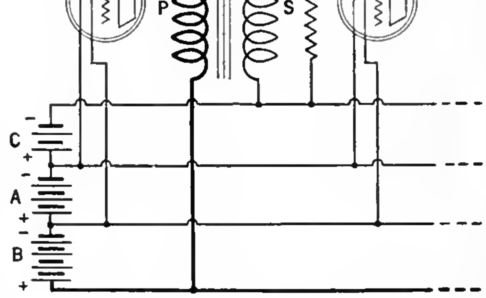


FIG. 10

types of radio-frequency amplifiers, let us examine the audio-frequency circuits.

AUDIO-FREQUENCY AMPLIFIERS

THE ideal audio-frequency amplifier would be made by using a resistance in the plate circuit of each tube and transferring the voltage variations directly to the grid of the following tube, the potential of the grid with respect to the filament being brought to a suitable value by means of a C battery, Fig. 8. This scheme is not practical, and in order to obtain the same results there are two general methods which theoretically should give exactly the same results as the directly coupled resistance amplifier, namely, by means of resistances and condensers, and by transformers.

It is obvious that in the case of resistance and condenser coupling, Fig. 9, if the reactance of the condenser for the lowest frequency is somewhat greater than the resistance of the leak, there would be a constant amplification at all frequencies, and therefore we would have ideal conditions. In the second method, if we had ideal transformers, that is, transformers in which the open cir-

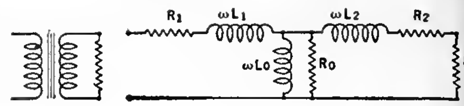


FIG. 11

cuit primary reactance is infinite, the leakage field between primary and secondary zero and the resistance of the windings also zero, and we connect a resistance across the secondary, as in Fig. 10, we would also have equal amplification of all frequencies, just as in the direct coupled resistance circuit of Fig. 8. In practice, the limitations are due to the magnitude of the primary reactance of the transformer, the leakage factor, and the distributed capacity of the windings. The eddy current losses in the iron may be represented by a shunt resistance across either winding, and, for that reason, in many cases it is not necessary to connect a high resistance across the secondary to get the effect of an equivalent resistance only across the primary. There are many excellent transformers on the market that have made their appearance within the last year or so that approach very closely the ideal conditions. They have a primary reactance of over 30,000 ohms at 50 cycles, which is about the lowest frequency transmitted by some of the very best stations, and the internal capacity so low that the upper frequency limit is beyond four kilocycles, which is the highest fundamental tone of the piano scale.

In order to illustrate, or rather to prove, that an ideal transformer used for coupling two tubes is equivalent to a resistance-coupling within a certain predetermined band of frequencies, let us assume that the transformer is of one-to-one ratio; for other ratios, it is only necessary to multiply the constants of the secondary by the square of the ratio of turns. A transformer is equivalent to a network as represented in Fig. 11 where R_1 and ωL_1 represent the copper resistance and the leakage reactance of the primary, R_2 and ωL_2 those of the secondary, R_0 the iron losses, and ωL_0 the open circuit primary reactance. R is the load. If the transformer approaches the ideal, R_1 and R_2 will vanish in comparison with R and also ωL_1 and ωL_2; that is to say there will be no leakage field, ωL_0 being very large in comparison with both R_0 and R in multiple, it may be taken off, and then the circuit will be reduced to a simple resistance.

Comparing the condenser-resistance and the transformer couplings, it will be noted that if the transformers approach the ideal, we may obtain a higher degree of amplification at all frequencies, since the ratio of turns may be made about three to one in practice without departing very much from perfect conditions. It will also be noted that when resistance-condenser coupling is used, a much higher plate battery voltage has to be used in order to bring the plate at rated potential. This has led to the so-called impedance coupling. Impedance coupling is identical with resistance-condenser coupling except for the substitution of the plate resistance by a very high reactance which has relatively low copper resistance, so as to get the full battery voltage

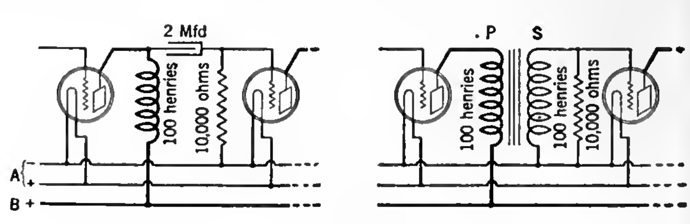


FIG. 12

on the plate. This system has just the same limitations as transformer coupling, and is theoretically equivalent to a one-to-one transformer, as shown in Fig. 12.

The faithfulness of reproduction of the demodulated wave at the detector grid, through the audio-frequency amplifier to the terminals of the loud speaker, may be preserved intact if the following conditions are fulfilled:

1. The amplifier must pass all the frequencies under consideration with an equal degree of amplification.
2. The plate impedances must contain no reactive component.
3. The tubes must be worked within the straight portion of their characteristics even for the loudest signal.
4. The grids must take a very small current if any; so small that the effective conductance at the peak values of that current may be negligible in comparison with the conductance of the plate circuit of the previous tube.

We have examined the requirements to fulfill (1).

It is quite essential to have plate impedances as nearly void of reactance as possible (2) because the dynamic characteristic of a tube with a reactance in the plate is not straight, but has the shape of a hystereis loop, and therefore the plate current variations are not proportional to the grid voltage changes.

Tubes are worked beyond the straight portions of their characteristics in many radio sets in order to obtain sufficient volume, and this is particularly true of the last tube, when insufficient plate voltages are used, and also when tubes of low power output are used in the last stage. For a moderate amount of volume, tubes such as the UX-171 with some 180 volts, should be selected, and for a volume approaching the original in the broadcasting room, a tube of five or more watts should be used with over 300 volts on the plate. In case a plate voltage sufficiently high is not available, for instance, when a set is operated from the 110 volt d. c. lines, an increase in volume may be obtained by the use of an extra tube and working the last stage in the positive part of the characteristic, provided that condition (4) may be fulfilled. The extra tube is not meant for additional voltage amplification, but simply to supply sufficient power to the grid of the last tube so that the grid may take an appreciable current, yet without lowering the voltage impressed upon it. Fig. 12 shows how this may be accomplished with impedance-capacity coupling, and with transformer and resistance coupling.

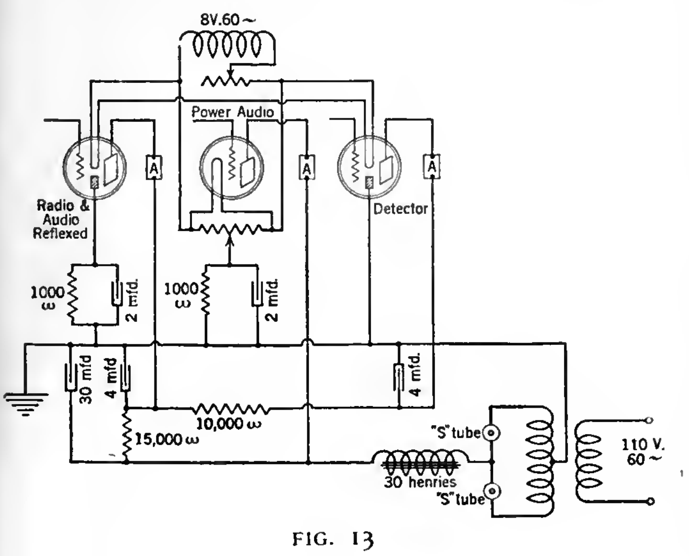


FIG. 13

Having preserved the wave shape of the modulated carrier from the broadcasting station and then detected and faithfully amplified to the terminals of the loud speaker, it is only necessary to avail ourselves of the best instrument on the market in order to complete the last link in the chain. As a number of very good papers on loud speakers have been read in the recent past, I shall not attempt to repeat their contents, and I will only make a few remarks on my personal experience with various types of speakers.

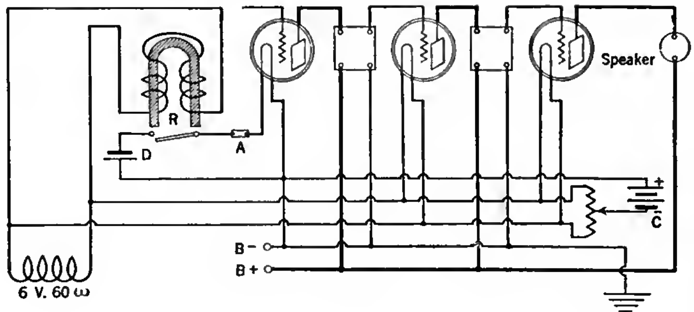


FIG. 14

TRANSLATING DEVICE OR LOUD SPEAKER

APPARENTLY there is no speaker on the market which can reproduce equally well all frequencies from 25 to 8000 cycles. Some very good types approach a linear and horizontal curve from 150 to 3000 cycles and can deliver a tremendous amount of tone, as, for example, the Hewlett and the Rice-Kellogg types. With large cones, very much lower frequencies may be reached. In 1923, I used a very large horn with an exponential curvature of expansion, approximately 19 inches in diameter at the opening and 71 inches long, with a very large diaphragm unit at the base. It has been working ever since quite well at the end of a three-stage resistance-condenser amplifier, with Western Electric high-mu tubes and a five-watt tube in the last stage (besides the last tube), using 400 volts B battery voltage, the latter being obtained from the 60-cycle 110-volt line, by means of S tubes. This horn gives a fairly uniform frequency reproduction from 120 cycles to about 1200 cycles, and then becomes weak very gradually, and for this reason I supplemented the deficiency by a short horn, with a condenser in series so that it would not rob the large horn of the lower tones. In order to obtain tones lower than 125 cycles, a cone was added, and the three of them together give a quality of reproduction that has received very favorable comments from all those who have heard them. The Western Electric cone seems to be at the present time the best all around reproducer of moderate price, and with a well made audio-frequency amplifier, all the harshness and rattle that it usually gives with carelessly designed sets disappears, and considerable volume almost approaching that of the Rice-Kellogg speaker may be obtained. This cone covers very well the two extremes of the musical scale for the average listener.

SOURCE OF POWER

NOW we come to another department of the radio receiver that has received considerable attention during the last few years, and that is the utilization of power from the electric light lines.

Power is delivered to consumers at a potential of 110-125 volts direct current, or 60 cycle alternating current. In some isolated cases 220 volts are furnished for lighting purposes, and also some lower or higher frequencies are found occasionally. On farms, a 32-volt equipment is often found. As the most common form of energy supply is the alternating current 60-cycle 110-volt lines, we will confine our discussion to this condition.

The first use of power for the operation of radio sets was to charge a storage battery by means of vibrating or tube rectifiers, there being no method of charging the B and C batteries. Later we find storage B batteries charged by means of tube rectifiers. Although the electrolitic rectifier was discovered by Doctor Pupin in 1895, it was not until recent years that it has been used for the purpose of charging radio batteries. Very good examples of chemical rectifiers are found in the market, and some of them are associated with storage cells of low capacity which they charge at a very low rate for considerable periods of time, or continuously. Alternating current has been used to energize the filament of transmitting tubes even in the days of radio telegraphy, but few have used it for radio telephone reception with any degree of success. As early as 1921, the author made a complete super-heterodyne receiver with all the tubes lighted by alternating current, and B and C potentials were derived also from the rectified current by the use of S tubes. To be sure, that particular receiver was not intended to cover thousands of miles, but on all local and moderate distance work it accomplished its purpose without objectionable hum. It must be said that the transformers used were of such type as would hardly pass frequencies below 200. Alternating current may be used to light the two last tubes of a receiver without an audible hum one or two feet away from a cone speaker provided that the following conditions are fulfilled: (1) The C voltage must be such that the grids never become positive with respect to any point in the filament unless the conductance of the circuit attached to the grid is large and takes a current many times greater than that which the grid may take at the peak values; (2) The middle point of the filaments must be at ground a. c. potential at all times; (3) The construction of the tube, with respect to the plate must be symmetrical with regard to the two ends of the filament; this is fairly well fulfilled in most of our commercial tubes; (4) The plate impedance must be non-reactive and large as compared with the internal plate resistance of the tube; in other words, the dynamic plate-current-grid-voltage characteristic must be straight within the portion used; (5) There shall be no inductive effects between the filament leads and the grids of the detector and audio-frequency amplifiers. From the first condition it follows that the detector cannot be lighted by alternating current except when moderately strong signals are available, and when the detection is accomplished by the curvature of the plate current characteristic at the negative end, and no condenser and leak device is attached to the grid.

ALTERNATING CURRENT TUBES

IN ORDER to solve the difficulty, and at the same time obtain a tube with very high amplification properties, Doctor Hull, of Schenectady, discovered a uni-potential cathode keno-pliotron which contains a separate heating element lighted by any current you please, and the cathode is at the same potential all over its surface. The McCullough tubes are built on this principle, and I had exceptionally good results with a pair of such tubes in a three-tube Roberts reflex set operated from a 60-cycle supply, using a power tube for the last audio stage with high plate voltage, as shown in Fig. 13. Unfortunately those tubes are not made with any degree of uniformity, and although their life should be theoretically much longer than thoriated tubes, it may be only one month, after which the emission has been reduced to a useless value, or the heater may burn out in a few weeks. If the McCullough tubes were properly made, they would unquestionably be the tubes of the future, and radio sets would be designed for them on account not only of the complete elimination of the A battery, but for their inherent high amplification with low plate resistance properties.

Another solution to the A battery elimination problem consists in using the same source of rectified current that furnishes the plate potential for the purpose of lighting the filaments. At present, with the 60-milliampere tubes connected in series, the problem is considerably simplified, since the size of filtering inductances may be materially reduced. Care must be taken to shunt every filament, or possibly every pair of tubes, with a certain resistance so proportioned that the plate currents from the following tubes that have to find their way through the series filaments will not increase the filament current of the tubes nearer to the negative pole of the d. c. source. Sets using $\frac{1}{4}$-ampere filament current, and operated by rectified a. c., are in existence. I constructed one that is still in operation at a club house after three years of continuous use. This receiver is a neutrodyne with 201-A tubes in series and a rectifier and filter unit containing S tubes and electrolytic condensers.

There are also hybrid sets in which a single dry cell is retained to energize the filament of the detector tube and the two audio-frequency tubes lighted by 60-cycle a. c. A relay, R, operated from either the B voltage supply, or from a. c., closes the circuit of the dry cell, D, through an "Amperite" A, and the filament of a WE-12 detector tube, Fig. 14.

The solution of the B voltage problem is very well known in principle, and the accompanying filters have been described in many publications. It should be emphasized that a B battery source costs a little more when made to supply over 300 volts than for less than 100 volts, and the resultant advantages of the high plate voltage in the last tube have been pointed out before in our discussion of faithfulness of reproduction. The resistances required to lower the plate voltage for the other tubes besides the last, and for the detector, fulfill a double rôle, that of voltage reducers and also filter impedances, as shown in Fig. 15. C battery voltage may be obtained from the same equipment as indicated.

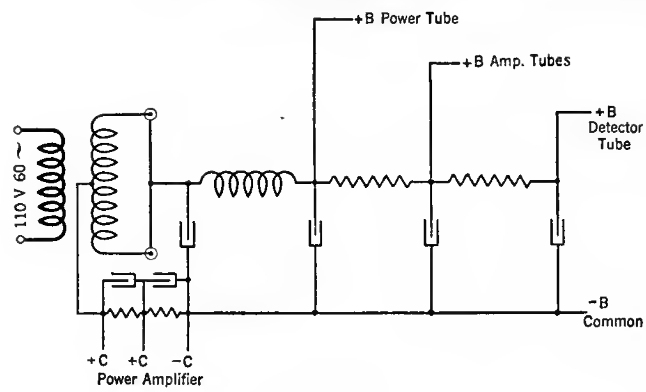


FIG. 15

[*Editor's Note:* With the new RCA UX-171 output tube, considerable undistorted power, without the use of high voltages, may be delivered to the loud speaker.]

In connection with some of these sources of rectified a. c., both for plate and for plate and filament power supply, an interesting phenomenon was observed during the early experiments that I conducted along these lines. A neutrodyne with tubes connected in series was supplied from a power unit similar to the one depicted in Fig. 15, using S tubes, two Mershon condensers, and a 25-henry RCA filter coil. By connecting a pair of head telephones with a condenser in series across the d. c. end, there was no sound to be heard, as was expected. Then the unit was made to supply the set, and a loud speaker attached to it, and still no sound or hum came forth from it; but as soon as the three dials of the neutrodyne were tuned to any particular frequency (the same for the three of them), a tremendous roar came from the speaker. This roar was aggravated if the carrier wave happened to be there and the set tuned to it. No amount of filtering would mitigate the racket and, if a separate ground was used for the set and the negative terminal of the power unit, the noise was somewhat diminished. Then, an apparently foolish thing was done; a tuned circuit, consisting of a coil and a condenser in series with it, were inserted in the ground lead that connected the neutrodyne to the radiator and when this contraption was tuned to the same wavelength as the neutrodyne, the roar disappeared just as if the power had been shut off. The case was undoubtedly one of shock excitation, and was proven to be such by operating the set from batteries and then running the power unit without any connection to the set. There was a faint sound like a saw mill the moment the a. c. switch was turned on, but the minute that any lead, even the negative terminal of the power unit, was touched to the negative terminal of the filament battery, the roar started almost as viciously as when the neutrodyne was operated by the power unit.

The rectifying tubes, when they allow the current to start with a rush, as in the case of the S tubes that I had, are equivalent to a rotating spark gap, or to a vibrating contact interrupter, in their production of severe interference with a radio set.

Another source of power for the operation of the filaments and plate current which has been used very little in receiving sets, yet is commonplace in transmitters, is the motor generator.

MOTOR GENERATORS FOR OPERATING RECEIVERS

AS EARLY as 1917 I successfully operated multitube sets by means of motor generators using various types of filters, and with the filaments in series, mainly with the idea of securing an absolute constancy of voltage and current, such as given by a synchronous motor generator set. Here we have many interesting effects produced by grounding or not grounding certain leads, even with perfect filtration of the commutator ripple and with a generator without visible sparking, but it would be rather long and involved to delve into this matter here.

Just let it be said that a well insulated d. c generator of a very small capacity, with field coils wound in series and with a large condenser across the brushes and another one across the output lead, as shown in Fig. 16, can operate very successfully a Freed-Eisemann receiver without noticeable noise.

When it is desired to energize a set that contains a semi-power tube from a source of direct current, it is not necessary to filter the current that lights the last tube, and a corresponding saving in the size of filter inductances may be effected by letting through them only the filament current of the other tubes connected in series. As a rule, one inductance of more than one henry is enough to filter out the commutation from an average radio set, except where motors with unbalanced armatures happen to be running in the vicinity of the set, which introduce tones of very low frequencies hard to eliminate with a single choke. The resistances that reduce the voltage for the operation of other tubes than the last, when large storage condensers are used, are sufficient to filter the B voltage supply.

A very useful device has appeared lately for the purpose of preventing the B voltage from rising to a dangerous value should any of the tubes go out. It consists of a tube of gaseous content that glows at about 90 volts, and which has the property of maintaining a constant current from a supply unit irrespective of the number of tubes or of the amount of emission in them. It is used in some power units made by the Radio Corporation of America.

As a result of our investigations we find that there is a very strong tendency toward the attainment of a reproduction as faithful as possible to the original, both in quality and volume. Then there is the tendency to simplify the tuning operations compatible with the required degree of selectivity, especially in the congested areas. And, thirdly, the elimination of adjustments and care and attention to the sources of energy to operate the set, using the available forms of power as supplied by the utility companies has received considerable attention. There is also a tendency to dispense with outdoor antennas in congested sections.

¶ *This paper by Mr. Aceves is the first of a new series, printed through the courtesy of the Radio Club of America.* RADIO BROADCAST *is the official publication of that organization and all papers delivered before the Club appear in this magazine. We, of course, do not assume responsibility for controversial statements made by authors of these papers. Readers of* RADIO BROADCAST, *we are sure, welcome the opportunity to read the papers presented by the Radio Club and we are very glad to have the opportunity to publish them regularly. Others will appear in early numbers of the magazine.*

B-POWER

By
JONAS B. JUDD

Most people have an idea in the back of their heads that they would like to be one of those high-salaried advertising writers. It must be a pretty easy way to make a living, so they think, to sit back in a swivel chair and conjure up high-sounding phrases that will lure the unwary reader into a purchase.

Who could not, for example, write a few paragraphs in the following style:

"Until you have sunk deep in the luxurious upholstery of the beautiful Overford car you will never know what riding comfort is. Over cobblestones, ruts, railway crossings or smooth boulevard, it's all the same to this marvelous Norge of the road. A touch at the throttle and you are away like a captive bird released; a touch at the brake and motion ceases as abruptly as the end of a song. Overford spells the best of beauty and the pinnacle of power in automobiles."

Alas, gentle reader, much as we dislike to disillusion you, the particular chair which we happen to occupy is of the dining room, rather than the swivel variety, and instead of soaring through the clouds in search of superlatives we have strict orders to keep our feet planted firmly on the ground.

Mr. Judd Wins Disapproval

Only last week we submitted a piece of copy on B-power units that had what the English would call "swank," not exaggerative frills you understand, and yet it did have that atmosphere of superiority which made competitors look like

Advertisement

YOUR receiver, whether it is an old model or the very latest type, can be improved by the installation of a high quality B-Power unit.

Everyone realizes the advantage of reliable B-Power, but few have the facilities or the time to select the right B-Power unit from the scores that are now offered.

The Raytheon Laboratories have simplified the choice. By selecting and approving only those that pass certain minimum requirements, we have made it possible for the radio owner to select his unit from a few good ones, rather than from a hundred of doubtful value.

Raytheon B-Power units are now made in a variety of styles that satisfy the needs of every receiver, and meet the approval of every pocketbook. Your dealer will recommend a Raytheon B-Power unit best suited to your needs. Raytheon spells reliable reception.

Raytheon, Type B, is a no-filament rectifier of ample capacity to eliminate B-batteries on even the largest ten-tube set.

Raytheon B-Power units are manufactured by Companies selected for their excellent engineering and production facilities.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
CAMBRIDGE, MASSACHUSETTS ★

RAYTHEON

poor second-raters. But did it win that warm welcome of approval that we anticipated? Not a bit of it. Instead, we heard something along the following lines from the boss, whom we'll call Mr. Raytheon for fun:

"Now see here, Mr. Judd, the July issue of 'Broadcast' closes on the 18th, and here you have spent two thousand words trying to 'paint the lily.' Don't say so many nice things about us and we'll like you better."

Of course we were quick to remonstrate that we hadn't said a thing that wasn't absolutely true and that the Raytheon B-power unit on our radio at home would prove that the results were in accordance with the description as written.

"Quite so, quite so," was the response from Mr. Raytheon. "But you simply must use more restraint, otherwise the public will think it a little too good to be true. Take this piece of copy, for example"—(Here a proof of the advertisement which accompanies this article was produced.) "Now that *is* conservative. But we figure that if we can get a fellow to talk it over with his dealer, or take one of the units home to try, we don't need to say another word."

He Tries Another Approach

Now you can see what a handicap we writers are under. Not only are we prevented from giving play to our imaginations, but we are reproved for writing the facts as we see them.

Undaunted by this gentle rebuff your humble correspondent, Mr. Jonas B. Judd, again took pen in hand. This time it was with a determined set of the jaw that signified the will to win, for now we would fortify our column with facts which every reader knew, at least if he did not know them he would check their accuracy by some simple calculations based on his own experience.

The more we thought about this new attack the better we liked it. What is so convincing as a re-statement in print of the things we already know and have told the wife? If Arthur Brisbane and Dr. Frank Crane could hold the front page by stating the obvious about life, certainly we could score a bull's eye by pointing out some facts pertaining to B-eliminators.

Thinking It Over

This is real sport. One of the best things about it is that in speaking of these rather important facts we can refer to authorities—and we always feel easier at mind when we can find someone else to rather hold us up. You see, we have been reading some radio books—big thick ones—containing a lot of big equations and peculiar looking signs. We hadn't the least idea what they meant but we were right at home when we came across a statement that read to the effect that one of the commonest points, at which amplifier noises originate, is the "B" supply. For we have been using, for quite a while, a B eliminator with a Raytheon tube, and we have never heard any of these noises.

These radio engineers must be an intelligent lot for here is another interesting statement from our "authority." He says that if the "B" voltage decreases to any considerable extent, the quality will be impaired. Now that we think of it, we can remember several occasions when this happened—before we began using a "B" eliminator. And it would have been terrible if it had occurred on some occasion

Advertisement

when Alexander Wollcott or Deems Taylor had just stopped in for a chat. (Neither of these gentlemen ever visited me, but I always live in hope that some day they will). But now, they can come around any time, for with a good "B" eliminator, my troubles with plate supply are over, forever.

One of my philosophically inclined friends was very much interested in my "B" eliminator. "It's really wonderful," he said, and taking on a philosophical air, he continued. "It is so silent! Yet it ceaselessly supplies your receiver with the essential electricity which is itself a silent, yet powerful, manifestation of nature." This was almost too much for me and I could only stare at him. I had never thought of my "B" eliminator in just that way. However, I suppose what he said, was true enough. You see, I had always considered the practical side of the thing. Yet, it does seem rather remarkable, that one tube is developed to receive radio signals, and that then, another tube, the Raytheon, is developed to supply them with plate current.

Did we refer to the quick-stopping qualities of that remarkable Overford car? Something about the end of a song, wasn't it? Well, it must have been one of those slow and never-ending "Forty-nine Bottles Hanging on a Wall" songs compared with the speed to which Mr. Judd's little joy ride of self-approval was brought to a stop. "Blank, blank-blank," was the aforesaid Mr. Raytheon's first comment. "Haven't you woke up enough to know that B-power units have arrived, and that they are not competing with batteries? People don't want to hear any more about battery troubles, besides Raytheon B-power units are in an absolutely different performance class, and B-batteries are necessary for homes that aren't wired anyway!"

So there you are. Now do you blame us for being angry? Just when we were about to make a name for ourselves in the last of the articles in this series we get tramped on like that. But we are going to get even, and the time is now, and the place is here.

Revenge Is Sweet

These B-power units aren't just all they are cracked up to be. We know because we're on the inside and we see some of the letters that come in. They hum! Yes sir, they do it almost every time, if your set isn't grounded. That means you have to connect a ground wire if you haven't already got one.

Another thing—some of them won't work at all with a Raytheon tube. We know a fellow who has had one for two years and at least a dozen filament tubes would work (they did for a while anyway) but when he put in a Raytheon tube instead he couldn't get a sound! Apparently the unit has to be designed for Raytheon.

As for the voltage output—the less said about it the better. The excuse as I get it is that the average voltmeter won't read the actual operating voltage because it draws so much current. But if a voltmeter draws more current than a radio set why doesn't it say so on the meter? We never did see a voltmeter label which read, "O. K. for use on power lines but not on B-power units."

Yes, they have their drawbacks, as you can see. But we *will* say this for them—if you want real quality reception you need lots of power, and that usually means a good Raytheon B-power unit.

ADVERTISEMENT

Improve Your Radio Reception this Summer!

Use a Majestic "B" Current Supply in place of the ordinary "B" batteries. It attaches to your lighting circuit and is easily adjusted to the voltage desired for your particular set. It gives you a constant, dependable, and uniform power (Voltage does not drop with use) and brings in full tonal strength yet with ample filtering capacity to eliminate all A-C hum, thus allowing you to operate your set at its highest efficiency. Current costs average 1-10 cent per hour.

Uses Nationally Known Raytheon Tube

All Majestic B Current Supply Units are equipped with the Raytheon tube (endorsed by numerous radio engineers and editors) which is a non-filament tube with full wave rectification, no liquids or back surge.

No Acids Used

The use of acid is objectionable because of the possibility of damage to furnishings and the corrosive action makes periodical replacement of the elements necessary.

Try a Majestic B Current Supply at Our Risk

Go to the dealer from whom you bought your set or any other reliable dealer and get a Majestic B, and attach to your set. We want you to judge for yourself. If you are not convinced that it improves your set—that it is the most satisfactory as well as most economical unit you have ever owned after a week's use, return it and your money will be cheerfully refunded. *Every Majestic is positively guaranteed for one year.* It is the most remarkable improvement yet made in Radio reception.

List Prices

Majestic Super B Current Supply complete with Raytheon Tube capacity 1 to 12 tubes including the use of new 135-150 volt power tubes. Price $39.50
West of Rocky Mts. **$42.50**

Majestic Standard B complete with Raytheon Tube, a smaller unit designed for sets having not more than six 201-A-type tubes of five 201-A, plus one 135-150 volt power tube. Price $32.50
West of Rocky Mts. **$35.00**

Operates on 100-120 volt-60 cycle alternating current.

GRIGSBY-GRUNOW-HINDS CO. ★
4540 Armitage Ave. **Chicago, Illinois**

RAYTHEON

The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has now been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," we present herewith a series of Laboratory Information Sheets. These sheets contain much the same type of information as has appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are referred to page 270 where it is explained in detail. The June RADIO BROADCAST, *in which appeared the first series of Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company.*

No. 9 RADIO BROADCAST Laboratory Information Sheet **July, 1926**

Data on the Roberts Four-Tube Receiver

COIL DETAILS, ETC.

ON SHEET NO. 10 is shown a diagram of the popular four-tube Roberts receiver. It is quite an easy matter to wind coils for this receiver, and there are given below complete data regarding their construction.

L_1 = 40 turns No. 22 d.c.c. wire wound on a 3" cylindrical form. The coil is to be tapped at every 10 turns.
L_2 = 45 turns No. 22 d.c.c. wire wound alongside L_1, on the same form. The spacing between L_1 and L_2 should be a quarter of an inch.
L_3,L_4 = 40 turn bunch-wound coil of No. 26 d.c.c. wire tapped at the center and wound over the filament end of the secondary winding, L_5.
L_5 = 45 turns No. 22 d.c.c. wire on a 3" form.
L_6 = Tickler, 20 turns No. 26 d.c.c. wire wound on a $1\frac{1}{2}$" cylindrical form and mounted at the grid end of the secondary winding, L_5.

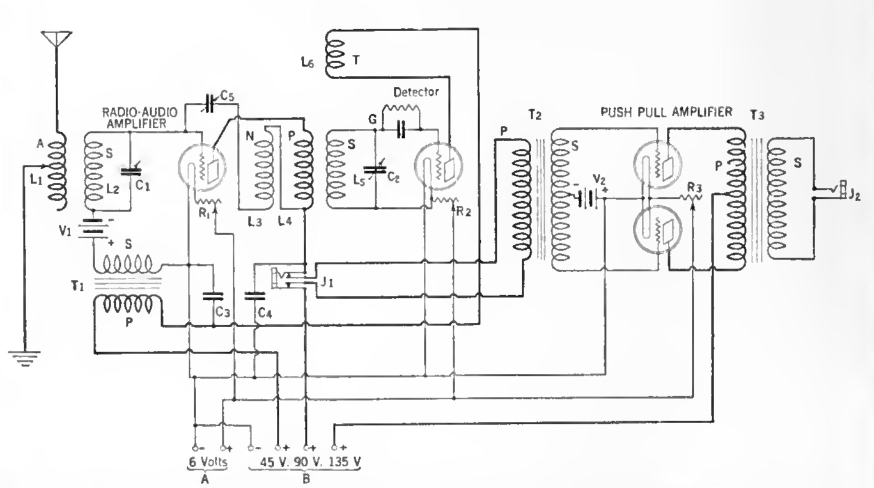
Besides the coils, it is necessary to have the following additional apparatus in order to construct the receiver.

T_1 Audio transformer; ratio about 4:1.
T_2 Input push-pull transformer.
T_3 Output push-pull transformer
C_1 Variable condenser 0.0005-mfd. capacity.
C_2 Variable condenser 0.0005-mfd. capacity.
C_3 0.0025-mfd. fixed condenser.
C_4 0.005-mfd. fixed condenser.
C_5 Midget variable condenser.
V_1 $4\frac{1}{2}$-volt C battery.
V_2 9-volt C battery.
J_1 Double-circuit jack.
J_2 Single-circuit jack
R_1 10-ohm rheostat
R_2 10-ohm rheostat
R_3 10-ohm rheostat
G Grid leak and condenser, 0.00025-mfd. condenser and a 4-megohm grid leak.

After the receiver has been completely built, it should be neutralized. The following method of doing this will, in general, be found the simplest. First, tune-in some local station that is broadcasting with a frequency of about 1000 kc. (300 meters). Advance the tickler until the detector begins to oscillate. Now, by varying the setting of the first condenser, it will be found that the pitch of the whistle will change. The variation of the pitch of the whistle is due to the fact that the radio frequency stage is oscillating and heterodynes the oscillations in the detector stage. When the receiver is properly neutralized, oscillations will not take place in the radio frequency amplifier, and the pitch of the whistle will not change. The problem is, therefore, to so adjust the neutralizing condenser as to bring about this condition. When the receiver is properly neutralized, the tuning of the first condenser will have no effect on the tuning of the second condenser.

No. 10 RADIO BROADCAST Laboratory Information Sheet **July, 1926**

The Four-Tube Roberts Circuit



Complete data on the sizes of the various units used in this circuit appear on sheet No. 9

Better now for $9.75 than it was in 1920 for $85

Recall that in 1920 a one-tube radio sold for $85. Today Crosley makes a better one for $9.75 (The Crosley Pup). There's the picture of Crosley manufacturing genius.

This year will see the millionth Crosley radio set produced. And somewhere, the first hundred still bring joy and satisfaction to their owners. Only this winter, one of Crosley's early one-tube radios won a nationwide radio reception contest, in which one-tube sets of all makes and dates were entered.

Powel Crosley, Jr., has so improved tuned radio frequency circuits in the present Crosley sets, that experts the country over have grown wildly enthusiastic over their performance.

"The first set to beat my pet——", says one fan. *"The only set I have ever seen that would tune out our local station in our building"*, writes another. *"How can Crosley do it for the money!"* is one exclamation, typical of hundreds of letters.

These new Crosley sets are truly wonderful for they not only represent a tremendous forward step in radio development, but are offered for even less than the closing-out prices of questionable and obsolete sets.

See and hear the new Crosley sets at your nearby Crosley dealer's.

Prices slightly higher west of the Rockies—For descriptive catalog write Dept. 20

THE CROSLEY RADIO CORPORATION, CINCINNATI, OHIO

Powel Crosley, Jr., President

Owning and Operating WLW, first remote control super-power broadcasting station in America

CROSLEY RADIO

Better-Costs Less

Manufactured under Armstrong U. S. Patent No. 1,113,149, or under patent application of Radio Frequency Laboratories, Inc.

★

Mass manufacturing operations on the million scale has so saved pennies in production that the public sees them reflected in dollars saved on the retail prices of Crosley radios.

One great example of this is the Crosley Musicone.

Its success created so great a demand that a saving to the public of $2.75 was soon effected through increased production. Today it is the fastest moving item in radio—its quality of reproduction and its low price is inducing the rapidity by which it is replacing thousands of other type speakers.

No. 11 RADIO BROADCAST Laboratory Information Sheet July, 1926

The UX-200-A Tube

A STABLE SOFT DETECTOR TUBE

A NEW detector tube, manufactured by the Radio Corporation of America, has recently been placed on the market. It is called the UX-200-A, and insofar as its operation is concerned, it is similar to the old UV-200, since its efficiency as a detector depends upon the presence of a gas in the tube. The major difference in appearance between this new tube and the UX-201-A, is the absence of the silver coating on the bulb. The UX-200-A has a bluish smoky color due to the special gas content.

The characteristics of this new tube, as given by the manufacturers, are as follows:

Design	Same as standard UX-201-A
Base	Same as standard UX-201-A
Filament Voltage	5 Volts
Filament Current	0.25 Amperes
Plate Voltage	45 Volts Maximum
Plate Current	2.0 Milliamperes
Plate Impedance	28,000 Ohms
Grid Leak	2.0 Megohms
Grid Condenser	0.00025 Microfarad

It might be of interest if the action of a gas-filled detector tube is reviewed, and an attempt made to show why such a tube can be made very sensitive for detecting signals.

The gas contained in the tube is composed of innumerable atoms, each of which consists of a nucleus surrounded by electrons, which are negatively charged. Normally, the positive charge on the nucleus exactly equals the negative charges on the electrons, and the atom is in a stable condition. When the filament is heated, it emits a great many electrons which are projected from its surface at very high speed. As they pass through the space between the filament and the plate, they frequently collide with some of the gas atoms, disrupting them and causing one or more of the negative electrons to be torn away from the atom, leaving what is called an ion, which is an atom that has lost one or more of its negative electrons. As soon as the negative electron is separated from its atom, it moves toward the positively charged plate with the other electrons emitted from the filament, and the plate current is thereby increased. Now, this breaking down of the atoms is called ionization, and it usually occurs at some particular value of grid and plate voltage. At the point of ionization, large changes in plate current occur with only small changes in grid potential, and if the tube can be operated at this point on the plate current curve, it will be very sensitive. In the old style UV-200 tube, the various voltages required very accurate adjustment in order to make the tube operate at the critical point of the characteristic, and this fact more or less detracted from its increased sensitivity. With a UV-201-A tube, however, very stable operation can be obtained over a wide range of voltages. As with the UV-200, operation of the UV-200-A is accompanied by a slight hiss, not unlike escaping steam, but it is not sufficiently loud to become bothersome.

No. 12 RADIO BROADCAST Laboratory Information Sheet July, 1926

The UX-171 Tube

THESE data on the new UX-171 tube show the important constants for this tube under various operating conditions. It is designed to handle relatively large amounts of input voltage and to deliver, with a low plate voltage, relatively large amounts of undistorted power. The table below shows the amount of power that can be delivered by the UX-171 under various input voltage conditions. This new tube will provide undistorted power handle the input with 135 volts on the plate. Its power output under the above input conditions will be below that of the UX-210. As a matter of fact, the UX-210 will deliver 1.08 watts while the UX-171 will deliver .3 watts under these conditions. This latter figure, however, is more than sufficient for all normal conditions.

It must be remembered that greater input voltages are required to secure greater output power.

Filament current	.5 amp	.5 amp.	.5 amp.	.5 amp.
Plate current	13.4 mils.	16.5 mils.	20 mils.	21.5 mils.
Plate impedance	2200 ohms	2200 ohms	2250 ohms	2325 ohms
Amplification constant	2.65	2.65	2.65	2.7
Mutual Conductance	1200 micromhos	1200 micromhos	1180 micromhos	1163 micromhos
Plate voltage	90	135	157.5	180
Grid voltage	−16.5	−27	−33	−40.5
Power output in watts	.1	.3	.486	.64

to a loud speaker in considerable volume without the use of high plate voltages. It is to be compared with the UX-112 and the UX-210 tubes. The UX-112 requires 135 volts plate battery to handle input voltages of 9 volts, and under these conditions will deliver a maximum of .12 watts of undistorted power. The UX-171, however, with only 90 volts on the plate, will handle input voltages up to 16.5, and will deliver approximately the same amount of power to a loud speaker.

With input voltages of 27, the UX-210 requires a plate battery of 350 volts, while the UX-171 will

There are few radio receivers that will deliver 27 volts to the grid of the last amplifier tube without more amplification (an additional stage), and without taking care of overloading all along the line of low frequency amplification.

The low impedance, 2000 ohms, of this tube, recommends it for use in high quality amplifiers. This is considerably below the impedance of loud speakers now on the market, which will tend to bring up the low notes. For these reasons, it will be wise to use an output transformer, as the manufacturer's circular recommends.

No. 13 RADIO BROADCAST Laboratory Information Sheet July, 1926

Charging Storage Batteries on Direct Current

NECESSARY RESISTANCES, ETC.

IF ONE has a convenient source of direct current, it is a comparatively simple matter to charge storage batteries. Although such charging will necessarily be done rather wastefully, it will nevertheless be cheaper and much more convenient than having it done at a charging station.

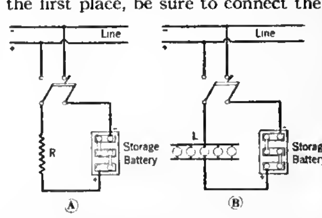
The charging may be accomplished by either of the two methods illustrated in the diagram. In A, the charging rate is determined by the value of the resistance R. Most of the power companies supply 110 to 120 volts, and for this line voltage, the following values of resistance should be used. The values are approximate and based on an average voltage of about 115.

CHARGING RATE	RESISTANCE	POWER DISSIPATED IN RESISTANCE
1 Amp.	110 Ohms	110 Watts
2 Amps.	55 "	220 "
3 "	37 "	330 "
4 "	28 "	440 "
5 "	22 "	550 "

The last column is given so that if a resistance unit is purchased care can be taken in choosing one that is capable of dissipating the power given in the table.

In place of the resistance units we can substitute a bank of electric lights as is illustrated at L, in B. The charging rate will be determined by the total wattage of the entire bank of lamps, and this total will equal the sum of the individual wattages of the lamps. If five 40-watt lamps are used, the total will be 200 watts. If the bank consisted of one 40-watt lamp, one 150-watt lamp, and one 60-watt lamp, the total would be 40+150+60=250 watts. By reference to the table, the total power (wattage) required, for any value of charging rate, can be found in the last column.

There are several precautions to be taken. In the first place, be sure to connect the positive side of the line to the positive side of the battery. If the battery is wrongly connected in the circuit, it is likely that it will be seriously damaged.



Secondly, be sure that none of the leads touch any metal surfaces, such as water pipes, for if this occurred a short-circuit might result. Thirdly, be certain that the charging rate is not too high. Information regarding this is generally given on the name plate of the battery. However, if this information is lacking, the charging rate should be determined by the heating of the electrolyte. As the battery charges, the temperature of the solution gradually increases, and no damage will result if the temperature is not allowed to exceed 110 degrees Fahrenheit.

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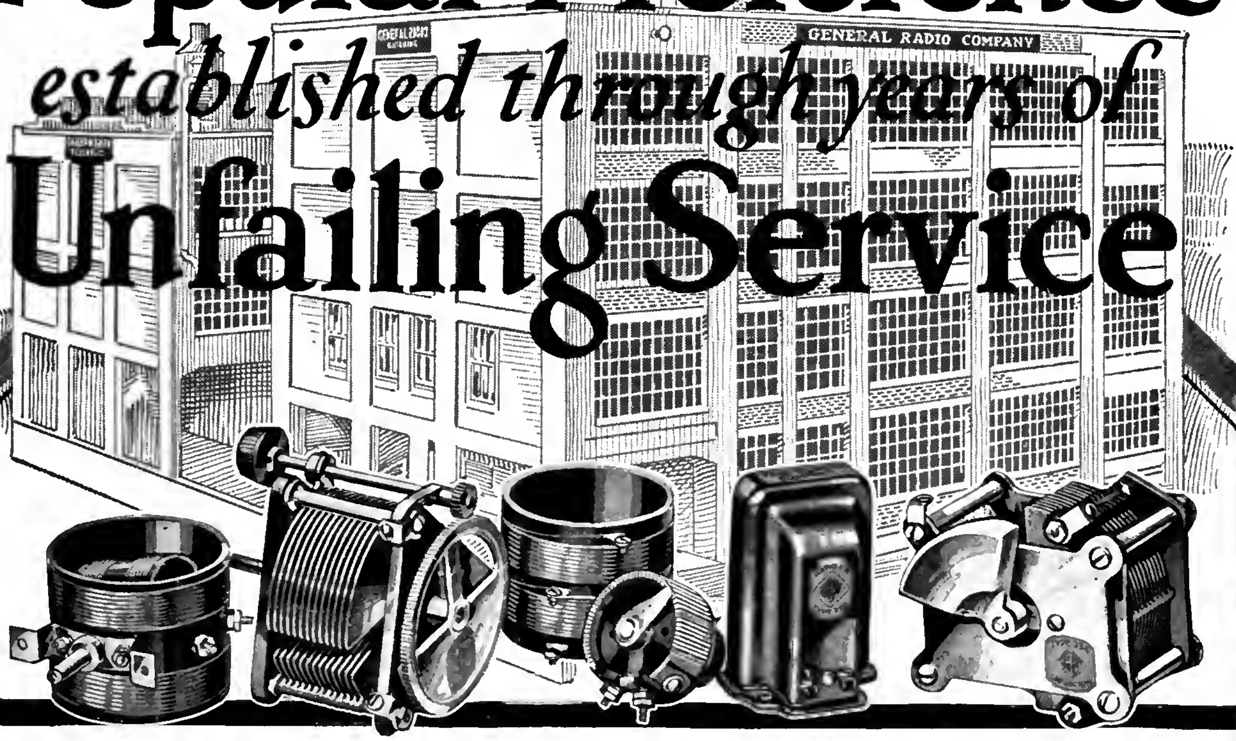


"By ye deeds shall ye be known," is an old yet significant proverb that applies to industry as well as to the individual. It is but natural that a pioneer organization which has pursued a steadfast policy of integrity should be the present day leader in its particular field of endeavor.

The General Radio Company has attained its position as the outstanding manufacturer of radio parts and laboratory instruments through the recognized merits of its products.

Since the early days of radio, amateur operators and set-builders have looked upon the General Radio Company as a time-tried producer of dependable apparatus.

The careful and conservative buyer of radio parts looks first to the reputation of the manufacturer. He knows from his own experiences and those of others whether this reputation warrants his confidence. It is this self-same confidence upon which the popular preference for General Radio parts is based.

All products of the General Radio Company whether for the scientist or set-builder embody the same outstanding craftsmanship and materials in their construction.

As a consequence the General Radio Company has gained the esteem and confidence of amateur operators and experimenters—an enthusiastic group who are thoroughly familiar with the technique of radio design and to whom the science of radio owes much of its rapid advancement.

You will invariably find General Radio parts "behind the panels of better built sets."

To-day General Radio precision instruments are standard equipment in nearly all the commercial and technical school laboratories throughout this and many foreign countries.

Every instrument made by the General Radio Company is thoroughly guaranteed.

WRITE FOR PARTS CATALOG 924-B ★

GENERAL RADIO CO. CAMBRIDGE 39, MASS.

GENERAL RADIO PARTS

Behind the Panels of Better Built Sets

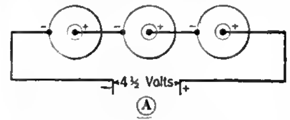
No. 14 Radio Broadcast Laboratory Information Sheet **July, 1926**

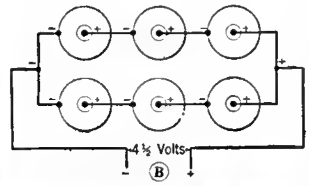
A Batteries

THE DRY TYPE

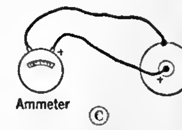
FOR the majority of receivers using type 199 tubes, a bank of dry cells can be used to supply the filament current. For portable sets such an arrangement is very convenient, and although, in general, the operation of these tubes will be found somewhat more expensive than storage battery tubes, their added convenience usually more than compensates for the greater cost of upkeep.

The common type of dry cell usually consists of a zinc container (which also acts as one element of the battery) in which is placed the active material. The active material is usually a mixture of powdered carbon and manganese dioxide moistened with a solution of sal ammoniac. Between the zinc container and the active material, there is usually placed a layer of blotting paper. The layer of paper acts, not only as an absorbent of some of the electrolyte but also as a separator which prevents the manganese dioxide from coming into contact with the zinc. If such contact does occur, an internal short-circuit takes place and the cell becomes useless.





The zinc case of the cell forms the negative terminal, and the positive terminal is a carbon rod that is placed in the center. This carbon rod is insulated from the zinc shell and does not react chemically with any of the other substances used.



The current from any one cell should not exceed one-quarter ampere. In the case of portable sets, it is not always possible to use that number of cells which would give greatest efficiency. In an installation in the home, arrangements should be made to use sufficient cells for most effective operation.

For any receiver using up to four 199 tubes, only three dry cells are necessary, connected as is shown in A on the accompanying diagram. If the receiver uses more than four tubes, two banks of dry cells should be used connected as shown in B.

Dry cells can be tested most easily by means of an ammeter. The instrument should be capable of reading up to about 50 amperes, and in testing the cell, it should be connected as in C. The cell should be thrown away if it reads less than five amperes.

No. 15 Radio Broadcast Laboratory Information Sheet **July, 1926**

Loop Antennas

THEORY OF OPERATION

A LOOP antenna is quite commonly used in connection with multi-tube receivers, especially super-heterodynes. The action of a loop is not quite as simple to understand as is the action of a simple antenna.

The theory of the operation of a loop is commonly explained in the following manner. Suppose we have two vertical wires separated by a distance of 200 meters, both of them insulated from each other and from the ground. Now, if a wave approaches from a direction perpendicular to the plane of the two wires, the wave will reach each wire at exactly the same time, and the voltages induced will be exactly in phase. If the wave approaches from some other direction, it will reach the two wires at different times and, therefore, the induced voltages will be out of phase with each other. If the wave approaches in the direction of the plane of the two wires and has a wavelength of 400 meters, the two induced voltages would be 180 degrees out of phase. Therefore, the voltage at the top of one wire will be a positive maximum when the voltage at the upper end of the other wire is at a negative maximum. Now, if the upper ends are connected together and the input to a receiver is connected across the lower ends, current will flow around the circuit, and if the circuit is tuned by a condenser, the currents will become comparatively large. The induced voltages will be greatest when the wave and the loop are both in the same plane, since this will result in maximum phase displacement between the voltages induced in the front and rear wires of the loop.

With regard to the design of loops, it will generally be found that the current induced in the loop varies directly as the area, directly as the number of turns, inversely as the resistance, and inversely as the length of the wave being received.

The common type of loop antenna consists of several turns of wire wound on a rectangular form. The turns should be spaced about one-half or one inch from each other, so as to keep the capacity low. The distributed capacity of a loop also increases with the number of turns. This capacity increases rapidly with the first few turns, and then the rate of increase becomes slower. A very satisfactory loop for use with a 0.0005 mfd. condenser can be made by constructing a four-foot square form and winding on it six turns of No. 22 wire. Such a loop would have a range of from 1500 kc. (200 meters) to 600 kc (500 meters).

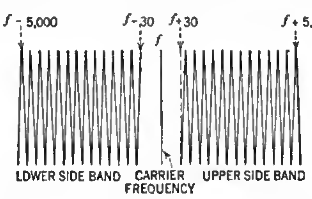
Generally, for satisfactory operation, no connection to ground is necessary. However, somewhat louder signals can usually be obtained if the low potential end of the loop is connected to ground. When such a connection is made, it is likely that the loop also acts as a small antenna by reason of its capacity to ground. In this connection, it should also be pointed out that the inner end of the loop should always be at the lowest potential.

No. 16 Radio Broadcast Laboratory Information Sheet **July, 1926**

Carrier Wave Analysis

HETERODYNE INTERFERENCE

RADIO waves travel with the speed of light—300,000,000 meters per second. Now, in any wave motion, the frequency, or number of waves passing a given point per second, multiplied by the wavelength, gives the speed with which the waves are traveling. If a train of railroad cars passes a given point at the rate of two cars per second and each car is fifty feet long, the speed of the train is obviously one hundred feet per second



Quite similarly, if the frequency of passing radio waves is one million per second, then the length of each wave must be 300 meters to make the speed come out the value stated above. Broadcasting stations have a frequency separation of 10 kilocycles to prevent heterodyning, and no uniform wavelength separation can be given that will be applicable throughout the broadcasting band. If we work with wavelengths, we must calculate anew the width of channel expressed in meters for every different wavelength. Thus a 10-kilocycle channel at three-hundred meters wavelength is only a three meter channel, while at three thousand meters wavelength, it is a three hundred meter channel. There are about nine times as many 10-kilocycle channels available between the wavelengths 30 and 300 meters as there are between 300 and 30,000 meters.

For very high quality music, all tones between about 30 and 5000 vibrations per second should be transmitted with equal efficiency. To transmit the former, we must transmit a frequency 30 cycles greater than the carrier and another 30 cycles less than the carrier, in addition to the carrier itself. To transmit the 5000-cycle note we must use the frequencies 5000 greater and 5000 less than the carrier, and to transmit all the intermediate tones, we must use the two bands of frequencies (called the upper and lower side bands) shown in the accompanying diagram.

The whole range of frequencies used is called a "channel." In the case just described, the width of the channel is 10,000 cycles. The important thing about all this is that broadcasting stations do not use only a single frequency or wavelength as might be supposed from the figure given at the top of the newspaper radio programs (that figure is the frequency of their carrier wave in kilocycles per second), but they each require a channel of definite width, and hence only a rather small number can work at once without their channels overlapping. Overlapping results in a continuous whistling sound (of high pitch if the channels overlap only slightly, and of lower pitch if the overlapping is greater).

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prizewinner for the current period will be announced in the August Radio Broadcast. *Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* Radio Broadcast, *Garden City, New York.*

Verniers and Their Application to Radio

THE word "vernier" has come to mean in radio terminology "a slow motion," but in engineering, it has kept its original meaning—to divide into, or measure, small parts. This method was called after its inventor, Pierre Vernier, who died in 1637.

After a careful examination of advertisements and descriptions of so-called vernier dials, only one (the Erla) was found that had a true vernier incorporated in its design.

In the "Now, I Have Found" department of the February, 1926, Radio Broadcast, page 490, appeared an article on a long-wave receiver, in which a piece of slotted bakelite was used to vary the distance between the coils. This method would be an excellent one for short-wave receivers, and if the bakelite strip were graduated with a scale, and a vernier added on the panel (one such as is shown here), very accurate calibration of the receiver would be possible. Coil positions could be recorded to the fortieth of an inch, or closer even, if a smaller scale is used.

To make such a vernier scale, first decide the size of the main scale divisions, then, with a good pair of dividers, divide on this vernier scale, into ten equal parts, a length equal to nine divisions of the main scale. In the illustration, Fig. 1, one quarter of an inch is supposed to be the main scale division. Therefore, the vernier scale which is divided into ten equal parts, is $2\frac{1}{4}$ inches long. Readings to one fortieth of an inch will be possible with the arrangement shown. If the main scale is divided into one-tenth divisions, and the vernier correspondingly changed, readings to one hundredth of an inch will be possible.

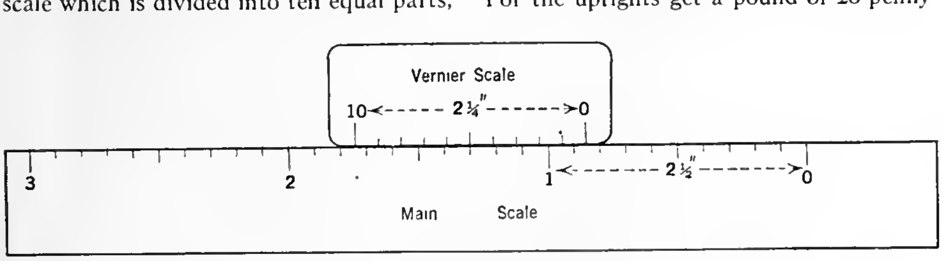


FIG. 1

Referring to the scale shown on this page, we see that the setting is 0.85, and this is the way it is read. First of all the reading on the main scale opposite the zero of the vernier scale is taken. In this instance it is less than 1—it is something over 0.8. To find out what the second decimal figure is, we glance along the vernier scale and see that one of the division lines on it will be in alignment with one of the division lines of the main scale. In the example given, this is at 5 on the vernier. The second decimal point is 5, then. The complete reading is therefore 0.85, as stated above.

The application of this vernier arrangement to the long-wave receiver mentioned previously, is a simple matter. The main scale is pasted on the sliding strip of bakelite while the vernier scale is pasted to the panel by the side of the sliding strip. When a station is heard, the coil setting may be jotted down by following the instructions above. It is simple to slide the strip of bakelite along until the required setting is found when tuning-in for a station which has previously been heard and its setting marked down.

Douglas H. Nelles,
Ottawa, Ontario.

A Lateral Basketweave Coil Form

DID you ever try to bore a dozen or so perpendicular holes in a small piece of wood to hold the pegs in a form for winding lateral basketweave coils? If yours was the usual experience, you have probably found that a drill press, or jig, is necessary in order to have the pegs stand up at right angles, as must be the case to make a neat looking coil.

The following method of making the coil form has proved very satisfactory. Use a piece of wood $\frac{3}{4}$ inch thick for the base. For the uprights get a pound of 20-penny finish nails. These are slipped into holes drilled at the proper points on a circle laid out on the base.

The difficulty is to drill the holes perpendicularly. Take a second piece of wood about 4 x 4 x $\frac{3}{4}$ inches. Drill a hole in its center, using a twist drill just a shade larger in diameter than the nails. Slip a nail through this hole and test with a carpenter's or draughtsman's square to see if it is perpendicular—which it probably will not be at first attempt. Drill other holes until you get one that is perpendicular. Mark it, and use it as a guide or jig, placing it over the base when drilling holes for the uprights.

Three tips: Slightly start each hole on the coil form base before using the jig; this makes it easy to slip the drill through the jig and locate the exact point to be drilled. Keep the jig and block in firm contact—use your foot or a clamp. File off any burrs on the nails just back of the points, and sandpaper any rust off the shanks.

Bases for various diameters can be made up for a few cents.

E. S. Anderson,
Springfield, Massachusetts.

Controlling Regeneration in the "Universal"

THE usual methods of controlling regeneration in the Radio Broadcast "Universal" are to employ a variable resistance either in series, or in parallel with a fixed tickler coil. Each of these methods has slight disadvantages, in the opinion of the writer. If the parallel method is used, the tube must be kept fairly near to the oscillating point or practically no regeneration will occur. Also the adjustment is apt to be very critical, which will cause the detector to break into oscillation suddenly. This is not always the case but is true of some detector tubes.

With the variable resistance in series with the tickler, the control is smoother than with the method just outlined. This latter method, however, causes the entire plate current to pass through the resistance with some losses to the audio frequency part, which should have free passage to the audio transformer. Changing the value of the series resistance in tuning will change the value of the B-battery voltage that is applied to the plate of the detector. As the resistance is decreased to cause regeneration at the lower frequencies (higher wavelengths), the plate voltage is increased. This is apt to cause instability at the lower frequencies.

The ideal method is one that will allow free passage of the audio frequency currents through the primary of the audio transformer, the batteries, and back to the filament. The radio frequency currents which cause regeneration should be separated from the audio currents and sent through a separate channel to the tickler coil, and then back to the filament. This may be easily done as shown by the diagram, Fig. 2. The primary of the transformer is connected to the plate of the de-

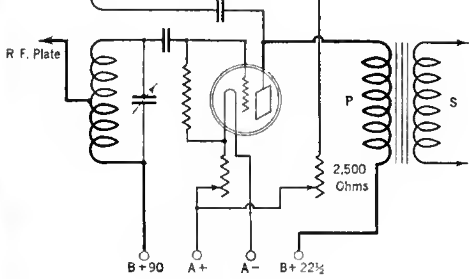


FIG. 2

tector tube and the other end of the primary to the B plus 22½-volt post. One side of a .002-mfd. fixed condenser is connected to the plate. The other side of this condenser goes to the end of the tickler which formerly went to the plate. The other end of the tickler goes to one side of a 2500-ohm variable resistance. The other side of this resistance goes to the plus filament post.

The audio currents are now allowed free passage to the transformer, and the plate voltage is the same at all times. The impedance of the primary of the transformer is sufficient to cause the radio frequency currents to pass through the condenser and fixed tickler coil where they cause regeneration. After going through the tickler they return to the filament by way of the variable resistance, which acts as a valve con-

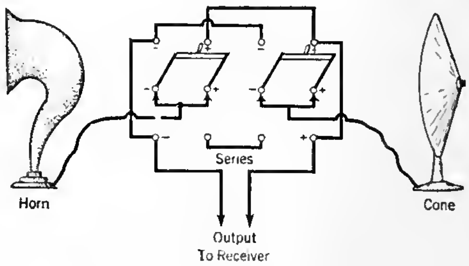


FIG. 3

trolling the amount of current flowing through the tickler. This control is very smooth; in fact it is so smooth that if the detector is adjusted to a sensitive condition at 1000 kilocycles, it will be quite sensitive at 550 kilocycles with the same adjustment.

Lawrence S. Babcock,
Jamestown, New York.

Loud Speaker Comparison

FREQUENTLY it is desired to test out two loud speakers for comparison; or, perhaps, two speakers are to be used alternatively. It is an accepted fact that the usual horn reproduces the treble somewhat better than the base, while the cone does the opposite. If the two instruments are connected in series, the reproduction is very satisfactory over the entire scale, possibly with a slight adjustment.

The wiring diagram in Fig. 3 will allow a quick change from one speaker to the other or to both either in series or parallel, by the use of two double-pole double-throw switches.

This system is applicable to the needs of radio dealers for demonstration purposes. When one of the instruments is not required, its switch is left in the "open" position while the d.p.d.t. switch of the speaker to be used, is placed in the parallel position.

L. H. Searing,
Auburn, New York.

A Constant Non-inductive Resistance Unit

FOR the home constructor and experimenter, especially now that resistance-coupled amplifiers are so popular, a cheap and easily constructed resistor that has a higher current carrying capacity than the paper strip type should meet with general approval.

The type described here is remarkably constant, and will carry much more current than the usual kind without changing its resistance. The writer constructed a number of them a year ago, and though the resistance increased slightly the first week, there has been no appreciable change since.

The materials needed are as follows: A bottle of India drawing ink; some scraps of muslin or other thin and absorbent cloth; a few pieces of glass tubing with an inside diameter in the neighborhood of 3-16 inch; a little brass or copper tubing which will fit rather snugly over the glass tube; some thin sheet brass, copper, or even a tin can if the latter is bright and clean enough to take solder readily; and some sealing wax.

First, soak a piece of the muslin in the ink and dry *thoroughly* over a radiator or stove.

Next cut your tubing into lengths to suit (an inch and a half is about right) by nicking with a file and breaking with the fingers.

Now make two ferrules out of the copper

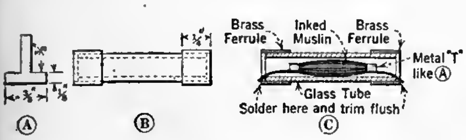


FIG. 4

or brass tubing about ¼-inch long. If you can't get the right size tubing, roll a piece of ¼-inch wide brass or copper foil around each end of each piece of tubing, and solder the joint.

One more thing and you are ready for the assembly. For each resistor you will want two "T" shaped pieces of the thin metal. See A, Fig. 4.

Cut the muslin into strips a half-inch less in width than the length of the glass tubing. Roll one of these strips up tightly until the roll is about an eighth of an inch in diameter and clamp both ends in the "T" shaped metal pieces by curling the top ends of the "T" pieces around the ends of the roll. Assemble as shown in C, soldering the ends of the "T" pieces to the edges of the end ferrules, and seal both ends by dipping in melted sealing wax, leaving long enough for the wax to flow all around between the glass tube and the ferrules. The excess wax on the outside can be easily removed with a knife. If difficulty is met with in completely closing the ends of the assembled units with the hot wax, the whole device may be filled with melted wax. If permanency of calibration is desired, it will be necessary to make air-tight seals at the ends; otherwise the resistance will vary with atmospheric changes.

The writer made up a dozen of these units, using Higgins ink, and varying the length between the "T" clamps from ¼ inch to one inch, measuring the resistance after assembly with a B battery and high-resistance voltmeter. The twelve ranged from 50,000 to about 250,000 ohms, and have been used with excellent results in resistance-coupled amplifiers, etc.

W. B. Harrison,
Miller School, Virginia.

An Easy Method of Doping Solenoids

The following method provides all the advantages of a "doped" coil and, as will be obvious, practically none of its disadvantages.

Having procured from a Kodak dealer a sheet, or sheets, of celluloid (this is as thin as tissue), and from a druggist a pint bottle of amyl acetate, first cut a strip of celluloid to cover a coil form of the desired diameter and length. If the strip is not long enough to overlap half an inch, join two pieces by softening a narrow band on the ends of two strips with amyl acetate and pressing them together. Bind the strip around the coil form, first applying amyl acetate in two or three places to the under side of the strip and the overlapping edges, and wind fifteen or twenty turns of cotton thread around the celluloid. Leave it for five or ten minutes until the celluloid is set.

Then remove the thread and wind the coil as usual, fastening the ends as you usually do. Now apply amyl acetate to the coil with a brush, fairly liberally, so that it will soak through to the celluloid. Allow it to dry slowly for half an hour, and then place over a register or radiator so as to volatilize all the chemical.

The acetate will have dissolved the surface of the celluloid to the consistency of cement and, as it dries, the coil will be firmly held. At the same time, the chemical will have evaporated practically entirely from the coil and it may be slipped from the form.

To wind a primary over a secondary, put a narrow strip of the celluloid over the secondary and repeat the process.

E. S. Anderson,
Springfield, Massachusetts.

Two Practical Methods of Mounting Crystals

For facility to change crystals rapidly and to obtain dependable contact in the circuit, this method of mounting crystals in miniature lamp bases will be found hard to equal, considering the cost.

Either the candelabra type of miniature lamp, or the bayonet type of lamp base, and corresponding sockets, are used as the means of holding the crystals. See Fig. 5. To prepare the lamp bases, the glass and plaster of Paris is broken out, and the crystal is hot-leaded into the base. Contact is made with the lamp socket through the

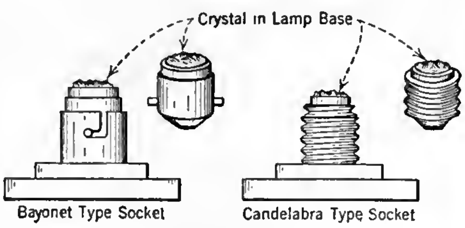


FIG. 5

terminals as is the case with the electric bulb, but only one side of the circuit is used.

By mounting several grades and types of crystals in these bases, change can be made immediately without loosening screws, and with a minimum of delay.

G. A. Luers,
Washington, District of Columbia.

Improvising Your Own Bus Bar

Soft drawn copper wire can be made into very effective lengths of bus bar with which to wire receivers. Usually this soft drawn copper wire is sold in rolls of 100 feet and any gauge may be obtained, depending upon the choice of the radio constructor.

To change the soft copper wire into stiff lengths, merely cut the roll into 10 foot pieces. Fasten one end of a piece in a vise and the other end into the jaws of a hand drill; then by alternately turning one way and then the other and at the same time exerting a pull on the wire, it will be observed that the wire stiffens perceptibly, after which it may be removed from the vise and cut into the desired lengths. Do not make the wire too stiff by the alternate turning or else it will become brittle, and break when bent.

Gene Ralele,
Montreal, Canada.

How the Patentee Is Covered by Law

Legal Protection Granted to Patentees and Instances of Important Suits—How the Inventor Collects His Royalties When Private Individuals Infringe

By LEO T. PARKER
Patent Attorney

THE matter of infringement of patents is an important subject about which the average individual is entirely unfamiliar. Considerable hearsay information is commonly being circulated among inventors regarding what is and what is not infringement, and just how it can be avoided. But through actual observation, the writer has determined that it is a subject concerning which the majority of individuals should become at least acquainted with the fundamental principles.

For example, it is generally thought to be perfectly within the law for a person to make a patented invention for his own individual use, but this is *not* permissible. A patent gives an inventor the exclusive right to make his invention, as well as to "use and sell" it. General home construction of patented radio circuits is generally allowed on the basis that the result is for "experimental purposes" and not for sale.

Then, too, there is another thing about which many inventors are misinformed, and that is the privilege, or, rather, the non-privilege, of selling an article which, when sold, is not an infringement of a patent, but which is so arranged that it is convenient for the purchaser to change the product into an infringing device. In this case, not only is the user liable as an infringer but also are the maker and seller. Not so long ago, a United States Court had occasion to decide a patent litigation between the Westinghouse Electric and Manufacturing Company, and the Independent Wireless Telegraph Company *et al.* The question, decided by the Court in favor of the Westinghouse Electric and Manufacturing Company, is one of particular importance inasmuch as a common point of discussion with varied opinions among radio fans is definitely answered by the decision.

The Independent Wireless Telegraph Company *et al,* employs a large number of wireless operators to whom the company furnishes wireless apparatus. The Company issued absolute instructions to the operators forbidding them to tamper or change any of the connections on the regular wireless sending and receiving instruments. But the operators soon discovered that considerably better reception of the incoming signals could be effected by simply connecting a wire from the antenna post to the plate. This simple change converted the receiving apparatus into one employing regeneration, which is a direct infringement of Armstrong's patent No. 1,113,149. Although the Independent Wireless Telegraph Company originally supplied non-infringing wireless apparatus to their employees, and the operators made the changes unbeknownst to the Independent Wireless Telegraph Company, the Court decided the practice was an infringement, and granted an injunction to stop the employees making the alteration. This decision was rendered although De Forest had, since the suit was filed, been awarded certain claims in the Armstrong patent.

AVOIDANCE SCHEMES DIFFICULT

ANOTHER practice that has gained considerable popularity among certain manufacturers and other persons, is supplying the users with certain parts of a patented product and giving instructions to the purchasers how to make other parts of the apparatus, so that when the whole structure is completed, an infringing instrument is the result. Such tactics as these do not avoid infringement of a patent, and both the user and manufacturer are liable as co-infringers.

Moreover, it is not fair to those persons who devote time, effort, and money in perfecting an invention to permit others to later devise some scheming means of indirectly avoiding infringement of the patent, without paying the inventor his just royalty. The Courts tend to favor the inventor, and will look through the shrewd methods employed to deprive him of his rights.

For these reasons, the Patent Offices at Washington are kept busy filing applications for patents of inventors who have faith in the Courts upholding their rights.

Another common method of avoiding payment of royalties to an inventor is to make and use the patented product without the knowledge of the inventor. The maker and user ordinarily believe that the amount of money involved is too small for the patentee to attempt to bring suit to recover. But if a sufficiently large number of actual users are properly located, the patentee is privileged to file but one suit to recover damages from each infringer, collectively. This method is permitted by the Courts to eliminate a multiplicity of suits. Thus an advantage is once again given to the patentee.

So for these various reasons, it is unwise to attempt to avoid paying just royalties to the originator of a radio article or device from which a user is deriving material benefits of far greater importance and value than the small royalty requested by the inventor.

Frequency Channels Used by U. S. Radio Stations

All New Stations, Including Broadcasters, are Assigned Wavelengths According to this List

WHEN a new radio station commences operation, it is assigned a definite frequency (or frequencies), this latter figure being allocated depending upon the type of service etc., from bands already decided upon. The list printed below gives these bands, and was drawn up at the Fourth National Radio Conference, and only differs slightly from that drawn up at the previous conference. Wavelength allocations by the Department of Commerce are based upon the information contained in this list.

An important matter treated by the Conference Committee was the utilization of the frequency bands above 2000 kilocycles (below 150 meters). Certain additional services have been placed in some of these bands, as will be noted from the list. Special thought was given to the application of the ultra-high frequency bands to beam and amateur services, but, as it will be noticed, no bands have as yet been specially put aside for the transmission of photographs by radio. It was concluded that certain of these channels should be available for experimental work other than beam transmission, and the allocations were accordingly modified in that respect. The Committee stated that the allocations above 2,000 kilocycles (below 150 meters) must be considered to some extent temporary or experimental.

A question of primary interest to the broadcast listener was also dealt with. This was relative to a proposed extension of the present band of frequencies used for the broadcasting service. It was fully recognized by the Committee that such an extension would result in a certain amount of relief of the present congested state of affairs, but it was not found feasible to make any extension without encroaching upon the major wave band used by the amateurs. Many present-day receivers too, would be unable to tune down to the extended wave band, so no alterations to the present band are put in force, nor are any such alterations likely.

KILOCYCLES	METERS	TYPE OF TRANSMISSION	SERVICE	REMARKS
95–120	3,156–2,499	CW and ICW	Government only	
120–153	2,499–1,960	CW and ICW	Marine and aircraft only	
125	2,399	CW	Government	Non exclusive.
153–165	1,960–1,817	CW and ICW	Point to point, marine, and aircraft, only.	
155	1,934	CW and ICW	Government	Do.
165–190	1,817–1,578	CW and ICW	Point to point and marine only	
175	1,713	CW and ICW	Government	Do.[1]
190–230	1,578–1,304	CW and ICW	Government only	
230–235	1,304–1,276	CW and ICW	University and college experimental only.	
235–285	1,276–1,052	Phone	Marine only	
245	1,224	CW and ICW	Government	Do.
275	1,090	CW and ICW	do	Do.
285–500	1,052–600	—	Marine and coastal only	
300	1,000	CW and ICW	Beacons only	
315	952	CW and ICW	Government only	
343	874	CW and ICW	Marine only	
375	800	CW and ICW	Radio compass only	
410	731	CW, ICW, spark	Marine only	
425	706	CW, ICW, spark	do	
445	674	CW and ICW	Government	
454	660	CW, ICW, spark	Marine only	Do.
500	600	CW, ICW, spark, phone.	Calling and distress, and messages relating thereto, only.	
500–550	600–545	CW, ICW, phone.	Aircraft and fixed safety of life stations.	Do.
550–1,500	545–200	Phone	Broadcasting only	
1,500–2,000	200–150	CW, ICW, phone	Amateur only	
2,000–2,250	150–133	—	Point to point	Do.
2,250–2,300	133–130	—	Aircraft only	
2,300–2,750	130–109	—	Mobile and Government mobile only.	
2,750–2,850	109–105	—	Relay broadcasting only	
2,850–3,500	105–85.7	—	Public toll service, Government mobile, and point-to-point communication by electric power supply utilities, and point-to-point and multiple-address message service by press organizations, only.	
3,500–4,000	85.7–75.0	—	Amateur, Army mobile, naval aircraft, and naval vessels working aircraft, only.	
4,000–4,525	75.0–66.3	—	Public toll service, mobile, Government point to point, and point to point public utilities.	Do.
4,525–5,000	66.3–60.0	—	Relay broadcasting only	
5,000–5,500	60.0–54.5	—	Public toll service only	
5,500–5,700	54.5–52.6	—	Relay broadcasting only	
5,700–7,000	52,6–42,8	—	Point to point only	
7,000–8,000	42.8–37.5	—	Amateur and Army mobile only	
8,000–9,050	37.5–33.1	—	Public toll service, mobile, Government point to point, and point-to-point public utilities.	Do.
9,050–10,000	33.1–30.0	—	Relay broadcasting only	
10,000–11,000	30.0–27.3	—	Public toll service only	
11,000–11,400	27.3–26.3	—	Relay broadcasting only	
11,400–14,000	26.3–21.4	—	Public service, mobile, and Government point to point.	Do.
14,000–16,000	21.4–18.7	—	Amateur only	
16,000–18,100	18.7–16.6	—	Public toll service, mobile, and Government point to point.	Do.
18,100–56,000	16.6–5.35	—	Experimental	
56,000–64,000	5.35–4.69	—	Amateur	
64,000–400,000	4.69–0.7496	—	Experimental	
400,000–401,000	0.7496–0.7477	—	Amateur	

[1]Ice patrol, broadcasting, etc.

Adapting the Roberts to the Long Waves

How a British Fan Made Coils Suitable for Reception of the B. B. C's Long-Wave Broadcaster

By C. A. OLDROYD

THE popularity of the Roberts circuit in Great Britain is steadily increasing, and it is probable that far more sets of this type would be constructed if suitable long-wave coils were available. England's principal broadcasting station, that located at Daventry and known as 5 XX, transmits with a frequency of 187 kc. (1600 meters), which is far above the upper wavelength limit of the standard Roberts coils. In addition to Daventry, there are many other European broadcasting stations transmitting on even lower frequencies (longer wavelengths) than Daventry, and the average British fan is not content unless he is able to receive these long-wave broadcasters as well as those employing the shorter waves. This is essentially the reason why the Roberts has not gained even more supporters over here in Europe than it has done. There are extremely few factory made receivers on the market that are not capable of at least picking up Daventry, this being accomplished, in many cases, by means of simple loading coils.

For nearly a year now, the author has been experimenting with the Roberts, and much interesting data has been gathered. During these experiments, to permit rapid changes with a minimum of trouble, a simple breadboard layout was employed. On the usual broadcasting wavelengths, which are almost identical to those employed by the American broadcasting stations, very excellent results have been obtained. When conditions have been favorable, broadcasting from American stations has been heard with perfect clarity.

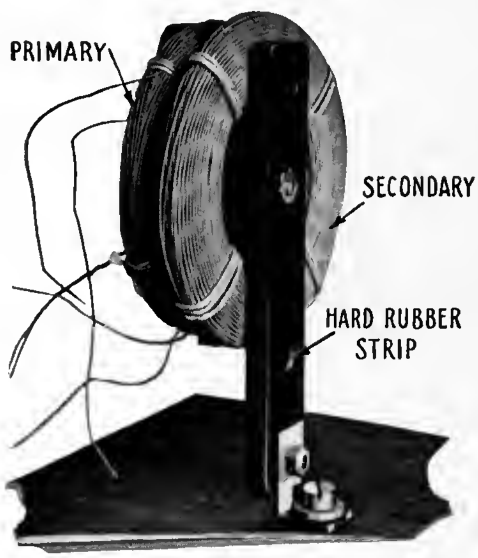
As most readers are aware, broadcasting in Europe is at present in a very bad state. Considerable interference is experienced through new stations opening up on frequencies which are already being used by other stations close at hand, and the constant heterodyning is the bane of the DX fans' existence. Up to the present time, the Bureau established at Geneva to look into radio matters, has been unable to improve matters to any great extent.

The Daventry station, fortunately, has been little affected by other stations, and many listeners in Europe confine themselves almost exclusively to listening to this station.

DATA ON THE COILS

THE ordinary three-circuit tuner fitted with honeycomb coils is easily changed to another waveband, but with circuits like the Roberts and the Browning-Drake, things are far more difficult. Nevertheless, the writer obtained very excellent results in adapting the Roberts for the longer waves.

Solenoid coils wound with wire of the usual gauges were out of the question, on account of their size. The only way out of the difficulty seemed to lie in the utilization of multi-layer coils wound with fine wire.



ANTENNA COIL
FIG. 1

These were wound on a machine such as the one shown in the RADIO BROADCAST of February, 1925, and the number of turns equalled about five times the number employed in the standard Roberts coils.

Fig. 1 shows the antenna coil; on the left is the primary, and on the right, the secondary. These two coils are separated by a strip of hard rubber about one quarter of an inch thick. Both coils are clamped to an upright strip of hard rubber, the latter being fixed to the baseboard by a metal bracket.

The radio frequency transformer is shown in Fig. 2 (page 276). Again the NP coil and the secondary are separated by a thin hard rubber strip, and both are attached to the upright. The tickler coil is shown lying in the foreground. It was arranged to swing parallel to the secondary.

The NP coil is tapped at the center, according to latest practice. As the wire used for these coils was very thin (about 30 gauge), no very startling results were expected, especially as the layers of the coils were close together. But when the set was switched on, the writer was agreeably surprised. When receiving Daventry, about 180 miles away, the volume was far greater than when receiving the nearest station, Manchester, 2 ZY, about seventy miles away.

Interference was absent, and only a faint whisper of Morse was heard at very rare intervals. Other long-wave stations, for

(Continued on page 276)

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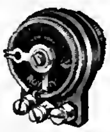

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THE "RADIO BROADCAST" LABORATORY SERVICE

How to Write for Technical Information, Repair Service, or Calibration and Measurement Work

As WAS announced in the June Radio Broadcast, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, Radio Broadcast Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to Radio Broadcast will be answered free of charge.
2. Non-subscribers to Radio Broadcast will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in Radio Broadcast.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in Radio Broadcast "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

In response to many requests, lists of the various groups of apparatus tested and approved by Radio Broadcast Laboratory will be mailed to all inquirers without charge.

REPAIR SERVICE FOR READERS

The service of the Laboratory will be further extended to aid readers, and we are glad to announce the inauguration of the "Repair and Service Department, Radio Broadcast Laboratory." The Laboratory will undertake to repair and put in condition, for a moderate charge, receivers built by readers. Only sets which have been described in this magazine will be eligible for this service. In a later number of Radio Broadcast, the full scope of the Repair and Service Department, will be outlined. Those readers who now have sets which they would like to submit, should communicate by letter with The Repair and Service Department of the Laboratory, Radio Broadcast, Garden City, New York. Facilities are available to repair readers' receivers at once. The Laboratory has no wish to compete with local radio repair services, but many readers desire to submit their sets directly to Radio Broadcast for attention and we are glad to accommodate those who feel that their local facilities are not sufficient to help them out of any difficulties they may have experienced.

CALIBRATION AND MEASUREMENT

A THIRD service of the Laboratory which is available to readers, is the Calibration and Measurement Service. For a moderate fee, wavemeters, coils, transformers, etc., will be measured or calibrated by the Laboratory. Characteristics of tubes will be measured and the Laboratory is in a position to perform other similar services. Communications on this subject should be addressed to the Director of the Laboratory.

Our correspondence indicates that an increasing number of readers of RADIO BROADCAST are becoming interested in home experimental radio work. Many of these newly interested experimenters have been led into this work through Keith Henney's articles which appear from time to time in the magazine, telling how the constructor can build and properly use his own simple and reliable wavemeters, audio- and radio-frequency oscillators and other important valuable laboratory apparatus. The Calibration and Measurement Service should be of practical help to these home experimenters.

Before apparatus is shipped to Radio Broadcast Laboratory for calibration, it should be preceded by a letter detailing exactly the purpose of shipment, and not until this letter has been acknowledged and permission given for it to be sent to the Laboratory, should it be dispatched. The greatest care should be exercised in packing all apparatus intended for the Laboratory, especially when tubes are included in the shipment

REPAIR SERVICE BLANK

Repair and Service Department
RADIO BROADCAST Laboratory,
Garden City, New York.
GENTLEMEN:

I am enclosing with this blank, a letter to the Repair and Service Department, RADIO BROADCAST Laboratory. I am not forwarding my receiver at this time but I desire to submit a receiver, which is a............, described in RADIO BROADCAST for

- ☐ Repair
- ☐ Overhauling
- ☐ Rewiring
- ☐ Inspecting and Test
- ☐ ....
- ☐ ....

NAME..............................

ADDRESS..............................

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST LABORATORY,
Garden City, New York.
GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

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A KEY TO RECENT RADIO ARTICLES

By E. G. SHAULKHAUSER

THIS is the ninth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the May RADIO BROADCAST, *and will be reprinted in an early number.*

R381. CONDENSERS. S. L. F. CONDENSERS.
Popular Radio. April, 1926, pp. 318–330.
"What a Straight Line Frequency Condenser Really Is," H. J. Harries.
The what and why of straight line frequency condensers leads the writer into a detailed discussion concerning the design and practical working principle of this type of condenser. The question of perfect straight line frequency condensers as applied to tuning circuits, is discussed from the mathematical and commercial viewpoint. Since coil capacity will to some extent vary the overall tuning of a circuit, the principal factor to be considered in determining the proper curvature of the plates is the frequency ratio, says the writer.

R570. DISTANT CONTROL BY RADIO. RADIODYNAMICS.
Radio News. March, 1926, pp. 1280 ff.
"Controlling Power and Motion by Radio," A. K. Laing.
Radiodynamics is defined as the science of controlling mechanisms at a distance without the aid of wires or other connecting materials. Five methods of signalling are considered: 1. Light waves, visible and ultra-violet; 2. Sound waves in air, earth, and water; 3. Earth conduction of electric charges; 4. Hertzian or radio waves; 5. Heat, or infra-red waves. These are considered in detail with various forms of detectors employed in picking up the energy used at the signalling stations.

R113. TRANSMISSION PHENOMENA. POLARIZATION OF WAVES.
Proc. I. R. E. April, 1926, pp. 205–212.
"The Polarization of Radio Waves," G. W. Pickard.
Prior measurements of wave polarization made at the lower transmission frequencies have uniformly shown vertical electric force at all distances from the transmitter. The present work extends such measurements to the higher frequencies, where it was found that the electric force at any considerable distance from the transmitter was no longer vertical, but, instead, predominantly horizontal. Comparative measurements were also made of radiation alternately horizontally and vertically polarized at the source, which indicated that the ratio of horizontal to vertical electric fields depended only upon the frequency, distance, and time of day, being substantially independent of the plane of polarization at the transmitter.

R582. TRANSMISSION OF PHOTOGRAPHS. PHOTOGRAPH TRANSMISSION.
Proc. I. R. E. April, 1926, pp. 161–179.
"Transmission and Reception of Photoradiograms," R. H. Ranger.
This paper describes the art of electric picture transmission from its inception, over 80 years ago, to the results of present day development. It is pointed out that the seemingly rapid strides that have been made in the art during the last ten years of its 83-year existence, may be attributed to the larger supply of electrical and mechanical contrivances from which modern photo-transmission engineers can draw. Picture transmission is not, as many think, a modern art. It is as old as the communication art itself, and this paper carries us through the work, ancient and modern, of photo-transmission engineers, commencing with that of Alexander Bain, in 1842.
A Denison facsimile of telegraph tape, taken in 1901, is shown, together with examples of the work of Korn taken in 1922; that of Hart-Lane in 1922; Bélin, 1924; Ferree, 1924; Jenkins, 1924; and results of the A. T. & T. system in 1925.
The basic elements of all picture transmission systems are shown to consist of synchronously covering a surface, point by point, at both transmitter and receiver, and electrically identifying point values at the receiver so that any integral section of the received copy will have the same relative tonal value as the identical integral section on the transmitting surface.
Economics is as important a factor in the transmission of pictures as it was in the establishment of a telegraphic system of communication, and the reason that the Morse code still exists is because it is the most economical means of getting a given amount of words from one point to another, in the shortest time, with the least power, over the greatest distance, and through the greatest amount of interference. The necessity of a picture shorthand was visualized and developed. Whereas the usual newspaper half-tone has 65 dots to the inch, and 5 tonal values are desired per dot, making a total of 325 photo-pulses per inch, the picture shorthand developed in the photoradiogram system reduced this to 65 photopulses per inch, giving a reduction, or shorthand ratio, of 5 to 1.
The photographic angle of the problem is touched on lightly, and the 11,000,000 mile-a-minute flight of the picture pulses from the transmitter to the receiver are followed through their several transformations in "slow-motion."
The development of this system of picture transmission is shown graphically by examples of photoradiograms taken from epochal stages in the course of the development. The commercial possibilities of this system are discussed, and in closing, it is pointed out that one very immediate and effective use to which photoradiograms will be put is in the transmission of words, printed, typewritten, or handwritten.

R344.3. TRANSMITTING SETS. SHORT-WAVE TRANSMITTER.
Popular Radio. April, 1926, pp. 348–355.
"How to Build and Operate a Low Power Transmitter," G. Fraser.

Complete details covering specifications for constructing a low power transmitter working on the higher frequencies (80 and 40 meters), are presented. A list of parts, including the size of meters, a circuit diagram, and photographs of completed sets are shown.

R381. CONDENSERS. CONDENSERS, *Paper.*
Radio. March, 1926, pp. 8–10.
"Paper Condensers," A. Nyman.

The mechanical and electrical properties of manufactured paper condensers, are given. Paper condensers are usually impregnated under pressure, the variation of pressure effecting the capacity as shown by a graph. The breakdown voltage, the life of a condenser, and the resistance, is determined by test, these factors entering into the manufacture. The methods of building up paper condensers, and the right and wrong way of making lead contacts to the foil, determine the operating characteristics.

R900. MISCELLANEOUS.
Proc. I. R. E. April, 1926, pp. 181–195.
"Sleet Removal from Antennas," J. H. Shannon.

A method is described for automatically releasing the antenna wires in case of an excessive sleet load. Also a new type of suspension condenser is described, which was developed for the sole purpose of preventing the low frequency energy going to the ground and thus making it possible to melt sleet from the individual antenna wires of the multiple tuned antenna without the use and inconvenience of complicated switching at each ground point. The mechanical as well as the electrical design of this condenser is unique. Further, it is believed that dinotrips and pliotrips can be adopted to power transmission lines in such a way as to prevent a big percentage of interruptions. These pieces of apparatus can be so arranged as to automatically introduce into the lines at intervals, additional lengths of conductor, and thus increase the sag. It is expected that for long spans over canyons, these would be almost indispensable.

510. NAVIGATION, APPLICATION OF RADIO TO. MARINE RADIO.
Proc. I. R. E. April, 1926, pp. 197–204.
"Recent Advances in Marine Radio Communication," T. M. Stevens.

It is stated that the development and use of vacuum tube apparatus by commercial and government stations has not only doubled the range of marine communications, but at the same time has made it possible to carry on a more extensive service with a far smaller number of corresponding stations on shore. Due to the much sharper waves emitted by vacuum tube transmitters, a greater number of channels have been opened for marine communications, which has resulted in the development of multiplex stations where marine activities are concentrated. Discontinuance of the use of spark apparatus at coast stations, and to a large extent on shipboard, has almost totally eliminated the interference formerly caused by spark stations.

R213. HARMONIC METHOD OF MEASURING FREQUENCY. GENERATOR FREQUENCY CALIBRATION.
Proc. I. R. E. April, 1926, pp. 213–216.
"A Method of Calibrating a Low Frequency Generator with a One-Frequency Source," S. Harris.

A simple method of calibrating an audio-frequency generator is described, a standard single frequency source of oscillation, in the form of a 1000-cycle carbon-contact tuning fork, being employed. The mathematical derivation of the final relations existing, are presented. The method makes use of the harmonics of the standard source and of the generator under calibration.

R343. ELECTRON TUBE RECEIVING SETS. NEUTRODYNE.
Proc. I. R. E. April, 1926, pp. 217–247.
"The Shielded Neutrodyne Receiver," J. F. Dreyer, Jr., and R. H. Manson.

A brief historical outline of the development of the neutrodyne receiver precedes the discussion of the construction and operation details of the improved neutrodyne. The unshielded neutrodyne presents many difficulties according to the paper, and these can only be overcome, with considerable overall efficiency for the receiver, if magnetic shielding is employed. Many of the magnetic and static fields which give trouble are taken up in the discussion. Using a shielded receiver of the Stromberg-Carlson type, three or four stages of r.f. coupling can be employed without stray interferences spoiling reception, neutralization may be made perfect, coil pick-ups on intermediate circuits from the outside are eliminated, and tuning adjustments may be reduced to two. The commercial design and construction of the new Model 610 Stromberg Carlson receiver is shown and described in detail.

R560. MILITARY ARMY AMATEUR RADIO
Radio. April, 1926, pp. 8ff.
"Army Amateur Radio Nets," R. Loghry.

Plans, whereby the transmitting stations of amateurs are organized to furnish communication channels for the National Guard and reserve components of the Army of the United States, are presented. These plans include the appointment of several radio stations in each Army Corps Area to carry out the work outlined. A certificate of appointment is issued the chosen applicant, who gives his services voluntarily, but he may withdraw at any time he chooses.

R343.5 HETERODYNE RECEIVERS. SUPER-HETERODYNE, *Best's Five Tube.*
Radio. April, 1926, pp. 10ff.
"Best's Five-Tube Super-Heterodyne," G. M. Best.

Best's five-tube, antenna connected, super-heterodyne receiver is shown and described. The intermediate frequency used is optional with the builder, the frequency to choose depending upon the frequency of any close-by broadcasting station, according to the author. Complete data on the constructions of this intermediate transformer are given. The salient features claimed for this new circuit are: Selectivity, even with the antenna connection; superb quality of output, due to the use of crystal detectors and high grade audio amplifiers; excellent volume with cone type loud speaker, by use of a power tube; economy in battery consumption, as only five tubes are required; and ease of assembly Complete details are presented.

R430. Interference Elimination. — Interference, *Method of Reducing.*
Proc. I. R. E. April, 1926, pp. 249–262.
"A New Method Pertaining to the Reduction of Interference in the Reception of Wireless Telegraphy and Telephony," H. de Bellescize.
The usefulness of directional reception and of resonant circuit selectivity in reducing the effect of atmospheric disturbances of reception is first considered. Assuming that sinusoidal forces coexist in a system with much larger impulses, it is shown that they will not pass through systems having internal frictional losses under certain definite conditions. The analogy between mechanical frictional systems and magnetic hysteretic systems is utilized in devising differential circuit arrangements whereby strong impulses, passing through two opposing circuits of controllable hysteric damping, are ultimately balanced out, whereas smaller sinusoidal currents are delivered at the output of the system. The application to radio reception is described in detail.

R113.6. Reflection; Refraction; Diffraction. — Reflection, *Short-Wave.*
Radio. April, 1926, pp. 21–23.
"Short-Wave Reflection Phenomena," E. W. Thatcher.
The author presents an analysis of experimental observations made on the higher frequencies (80, 40, 20-meter band) over a period of several months. Comparison is made with like phenomena occurring in the case of light waves, since radio waves and light waves are electromagnetic in nature, and therefore subject to the laws of reflection and refraction. The conclusion arrived at shows that each band has a maximum and minimum average range, and all three bands are necessary to effectively cover both short and long distances during twenty-four hours of the day.

R402. Short Waves. — Short-Wave Receiving.
Radio. April, 1926, pp. 29ff.
"The Efficient Reception of Short Waves," W. L. Nye.
A summary discussion of the various types of well known circuits as applied to the reception of the higher frequencies, is presented. The Hartley, Reinartz, Colpitts, the standard three-circuit, and the capacity-controlled feedback, are several of the circuits mentioned. Each circuit has its own peculiarities which must be taken into consideration, although all of them give about the same results, states the writer.

R386. Filters. — Filter Design.
Radio. April, 1926, pp. 31ff.
"Design of Low-Pass Filters," J. B. Dow.
Various arrangements of inductance and capacity filters are shown diagramatically, and their particular application to a 60-cycle frequency circuit considered. The arrangements presented are divided into three groups, each group having its peculiarities regarding "attenuation" and "cut-off frequency." The details of design of these circuits are presented mathematically, and then the ideas applied to specific problems.

R402. Short Waves. — ransmitter, *Short-wave*
QST. April, 1926, pp. 8–13.
"Breaking Into Amateur Transmission," J. M. Clayton.
A description of an inexpensive short-wave transmitter using UX-210 tubes, is given for the benefit of the beginner in amateur radio. Details of construction of the various parts are worked out, a list of materials given, and complete assembly is shown.

R281.9. Insulating Materials. — Isolantite.
QST. April, 1926, pp. 14–16
"Isolantite—A Unique Material," A. C. Lescarboura and R. S. Kruse.
A new insulating material, Isolantite, is being extensively used in radio apparatus because of its hardness, toughness, moisture-resisting qualities, and exact machining properties. The authors describe the new material, how it is machined and then hardened by a special heat-treating process. Its dielectric strength is over 30,000 volts per millimeter. The phase angle is less than .010 degree, showing low dielectric losses. The dielectric constant is 3.6 and at 50 per cent. relative humidity, the resistivities are 6×10^{14} ohms per cc. and 5×10^{15} ohms per sq. cm.

R343. Electron Tube Receiving Sets. — Mu-rad Receiver.
QST. April, 1926, pp. 17–22.
"The Making of a Single-Control Receiver," A. S. Blatterman.
The electrical details to be taken into consideration in a single-control two stage r. f. amplifier are outlined in connection with the Mu-rad receiver. In designing a new type of r. f. transformer, the circuit characteristics inherent in the intermediate stages of the set had to be made equal to those in the first stage or antenna tuning coil. This necessitated considerable research and investigation concerning the effects of coil and tube capacities on each other. For specific reasons, the volume is controlled by varying the plate potential in the r. f. stages. Diagrams and photographs are presented to give the necessary details.

R356. Transformers. — Transformers, *Audio.*
QST. April, 1926, pp. 29–32.
"Peaked Audio Amplifiers," R. S. Kruse.
In order to obtain maximum volume in c.w. telegraph receivers without introducing too much distortion and interference, the audio stage transformers should have a definite peak which should fall somewhere around 1000 cycles, says the author. The amount of peak, or sharpness, can either be made permanent through specific transformer construction or controlled through outside circuit arrangements. Since the tube impedance as well as the various circuit constants affect the location of this peak and its value, each circuit must be analyzed for best results.

R376.3. Loud Speaking Reproducers. — Diaphragms.
Radio News. April, 1926, pp. 1419.
"A New Loud Speaker Diaphragm," G. S. Bennett.
A new type of loud speaker diaphragm is described. It is made of a metal skeleton with a special parchment paper cemented to the metal. This method of construction is said to have remarkable reproducing qualities when used as a vibrating element in loud speaker units. Illustrations show method of making and using this new diaphragm.

R376.3. Loud Speaking Reproducers. Loud Speakers.
Radio News. April, 1926, pp. 1422ff.
"The Passing of 'Canned Music,'" Major J. S. Hatcher.
Major Hatcher reviews the developments made in sound reproduction, referring both to the radio and the phonograph reproducers in this article. The exponential horn is considered the proper type of horn to use for reproduction on high and low frequencies, the "cut-off" frequency at the lower range depending upon the rate of expansion. Thus a long horn is better than a short one, he says.

R382. Inductors. Toroidal Coils
Radio News. April, 1926, pp. 1436 ff.
"All about Toroid Coils," S. Harris.
Toroid coils, with their confined field, are used mostly in r. f. amplifier stages, where magnetic coupling between stages is not desired. Their method of construction, and the relation existing between inductance, wire size, coil diameter, and number of turns, is compared in the several graphs and the accompanying discussion.

R148.1. Distortion Distortion.
Radio News. April, 1926, pp. 1438–1439.
"What is Distortion," Dr. A. Anderson.
It is the writer's purpose to emphasize that distortion covers a multitude of sins, and to point out some of the most common types of distortion found in a radio receiver. Enumerated, these are primarily: Wave deformity, static, microphonic tubes, poor loud speakers, poor contacts, internal electrolytic action of B batteries, and poor broadcasting. All of these sources of trouble are taken up in turn, analyzed, and remedies suggested.

R134.4. Regenerative Action. Regeneration.
Radio News. April, 1926, pp. 1440ff.
"What is Regeneration," K. W. Jarvis.
The principles of regeneration, or "feed-back," in radio receivers, are analyzed. Regeneration results when a higher voltage is produced across the tuned plate coil than across the grid circuit of the same tube. The part the tickler plays in setting up oscillations is very important, and is considered at some length. A fundamental principle is emphasized, namely, that the voltage across the tuned circuit will always adjust itself to such a value that the power loss and the power input are equal. The author proceeds to prove that regeneration and oscillation are one and the same thing. (Continued in May issue).

R381. Condensers. Condensers.
Radio Broadcast. May, 1926, pp. 33–36.
"Will the New Type of Condenser Improve My Set," K. B. Morecross.
The three types of condensers, s. l. c., s. l. w., s. l. f., are compared, their advantages and disadvantages in circuits discussed, and curves presented showing the relation existing between capacity, frequency, and wavelength, against dial settings. Formulas are given showing by what method the s. l. f. and the s. l. w. condenser plates are designed. Many makes of condensers are shown in the photographs accompanying the discussion.

R090.1. History: United States. History
Radio Broadcast. May, 1926, pp. 19–22.
"Breaking Into the Wireless Game," J. M. Baskerville.
Mr. J. M. Baskerville gives an account of his experiences in the field of wireless telegraphy during the early days of its history. Back in 1905, he installed some of the first wireless sets on shipboard, and operated installations on land and sea. The early history of wireless is graphically told by the author. He shows a daily "wireless" newspaper of the year 1906.

621.354.3. Battery Charging Devices. Chargers.
Radio Broadcast. May, 1926, pp. 47–51.
"Trickle Chargers for Your A Battery," J. Millen.
The author covers in detail the commercially available types of chargers and power units used in supplying A battery current to receiving sets. Constructional details are also presented for making a trickle charger of the lead-aluminum type.

R073. Training of Operators. Code for Operators.
Radio Broadcast. May, 1926, pp. 56–59.
"Easy Methods of Conquering the Radio Code," E. H. Felix.
The fascinating game of wireless telegraphy in the dot and dash language is related in this article. Mastery of the code is essential in order to listen-in on the amateur and commercial channels which the broadcast listener knows nothing about. How to proceed in learning the code, how to send and receive, and how to build a simple long-wave receiver to tune in on the long-wave time signals which are detailed in an accompanying schedule of transmissions, is told by the writer.

$1000 For Radio Essay

WE ARE informed by the Faculty of Law of Northwestern University that the sum of one thousand dollars, together with a suitable medal, will be awarded to the author of the best essay, or monograph, submitted by March 1, 1927, on "The Law of Radio Communication," the scope to include the aspects of the subject as a problem of international law and as a problem of legislation in the United States. The prize is known as the Linthicum Foundation Prize, and is one of two, the second being on the subject of "Scientific Property." To be eligible for the award, the author must be, at the date of submission, a member of the bar or a student registered in a law school in the United States or Canada. The full conditions of the award may be obtained by writing to: The Linthicum Foundation, Northwestern University Law School, Chicago, Illinois.

(Continued from page 268)

instance Radio Paris, 171 kc. (1750 meters), and Koenigswüsterhausen, Germany, 231 kc. (1300 meters), came in at very good strength. In the writer's opinion, the Roberts performed far better on the long waves than on the broadcast waveband. If interchangeable coils are used, a set could be adapted to either waveband at will; to keep the set neutralized with both sets of coils, the neutralizing condensers could be attached to the coils. The ends of the coils could be fitted with pins, similar to the General Radio formers, these pins would then engage in suitable bases.

SOLENOID COILS

The next step was to see what results could be expected with solenoid coils wound with very fine wire. Unfortunately, at the time of writing, these experiments have not been concluded, but the following

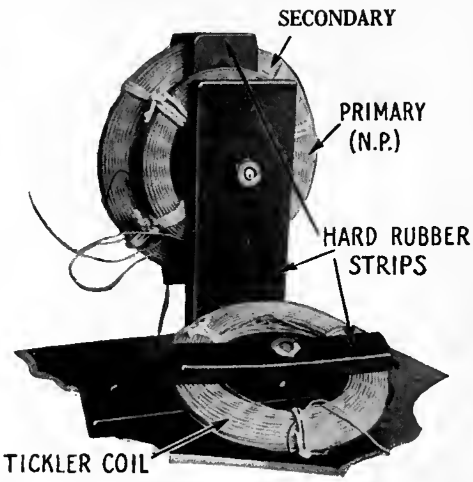

FIG. 2

may be of interest. A three-inch form wound with about two hundred turns of fine wire—about No. 28 gauge—brings in Daventry quite well on a straight crystal set; and Daventry is 180 miles away!

This coil is about $1\frac{3}{4}''$ long, so that quite compact long-wave coils seem to be possible. If only American manufacturers would go into the matter of long-wave Roberts and Browning-Drake coils, fans of all nations will benefit, and in the next International Tests, American DX hunters would stand a good chance of hearing Daventry and other European long-wave high-power stations.

Another plan would be to make the long-wave set to tune to a band having a maximum of about 120 kc. (2500 meters). In this case, the long-wave stations could be received with the "straight" set, while to receive the stations transmitting on the standard broacast band, an O'Connor frequency changer could be used. This latter was described in the June and August, 1925, issues of Radio Broadcast. With suitable oscillator couplers, even the very short-wave stations could be received.

By referring to the circuit diagram of the four-tube Roberts on Laboratory Information sheet No. 10, and the data on sheet No. 9, the positions and size of the coils will be clearly understood.

WHAT OUR READERS WRITE

A Bouquet from Australia

ON PAGE 224 of the December RADIO BROADCAST, appeared a list of Australian broadcasting stations which was forwarded to us from Australia by Mr. A. W. Watt, editor of Australian *Wireless Weekly.* Here is an excerpt from a later letter from Mr. Watt which followed the publication of the list in question.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
Sir:

I am glad to see that you accepted my little correction of Australian broadcasting stations in the spirit in which it was offered. Perhaps I should tell you that I regard RADIO BROADCAST as the best radio publication put out in the United States. This is not merely idle flattery, but the opinion is based on direct comparisons which I have made for a long time between all your American radio journals.

Very truly yours,
A. W. WATT,
Editor.

Criticizes Mr. Marriott's Statements

IN HIS article entitled "How Radio Grew Up," which appeared in the April, 1926, RADIO BROADCAST, Mr. Marriott referred to Guglielmo Marconi as a sales engineer, substantiating his belief by remarks to the effect that Marconi's patent taken out in England in 1896 was merely a combination of the Hertz-Branly-Lodge-Tesla-Popoff devices. Now, whether or not these statements are entirely justified, is a matter of opinion, so it was with considerable interest that we read the following letter from Mr. Packman, who is the vice-president of Dodge's Telegraph, Railway Accounting, and Radio (Wireless) Institute.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

To anyone who is familiar with the developments in the art of radio communication, and who has studied the discoveries in the field of science which preceded it, it must be with deep resentment that he reads the statements in Mr. Marriott's article "How Radio Grew Up," which appeared in your April issue. In fairness to Marconi, and as a matter of common honesty, it seems that the least you can now do is to make an effort to correct the erroneous impressions which such an article must leave in the minds of the present generation of radio enthusiasts.

The history of wireless telegraphy dates back to the earliest days of the Morse telegraph, and many schemes, both practical and impractical, were proposed and tried out with varying degrees of success, over short distances. Prominent among the names of the early experimenters are those of Morse, Lindsay, Trowbridge, Hughes, Dolbear, Edison, and Preece. It must be recognized, however, in considering these names, that there is a difference between wireless telegraphy and radio telegraphy. Radio telegraphy, as we use the term to-day, is one form of wireless telegraphy, but the wireless telegraph systems used by the experimenters named above were not radio. Their systems were based on various electromagnetic and electrostatic induction processes, or on conduction through the earth, or through water. There is no evidence that any of them had any notion, whatever, of free traveling electromagnetic waves. Dolbear and Loomis both show antennas or elevated wires as parts of their system, but they were attempting to utilize what we now term the "induction field" of the antenna, whereas in radio communication we make use of what is termed the "radiation field," that is, that portion of the antenna field which becomes detached from the antenna, when the frequency is sufficiently high.

Radio communication, like many other things which we enjoy to-day, had its beginning in the field of pure science. The names of Helmholtz, Maxwell, Fitzgerald, and other scientists, are so well known, and their work so fully recognized, that no one disputes their association with the beginning of the art of radio communication.

The history of radio communication, as we use this term to-day, is usually dated from 1865, in which year Maxwell enunciated his electromagnetic theory of wave motion. This theory was so abstract, so it is recorded, that even scientists of that day took but little notice of it, and it was not until the publication of Hertz's experiments in 1888 that the subject of electromagnetic wave phenomena became of general interest in the scientific world.

During the next few years, much knowledge was gained by scientists in various parts of the world through the reproduction of Hertz's experiments. Prominent among those taking up this work were Branly, Popoff, Lodge, Fleming, Crooks, and others. Branly invented the coherer, which was a more sensitive detector of electric waves than was the spark gap used by Hertz; Popoff applied the Branly coherer to the recording of electrical phenomena occurring in the atmosphere. In 1892, Crooks published a paper on "Some Possibilities of Electricity," and in speaking of electromagnetic waves made the following statement: "Here then, is revealed the bewildering possibility of telegraphy without wires." The fact remains, however, that it was not until 1895, some seven years after the publication of Hertz's paper, that a successful demonstration of wireless telegraphy, by means of electromagnetic waves, was made, and then by Marconi. It is interesting to note also, that at the time of the publication of Hertz's paper, Marconi was a very young man, in fact, a youth of some fourteen years, whereas Branly, Popoff, Lodge, and others who became interested in Hertz's work, were in their prime.

Mr. Marriott would have your readers believe that Marconi was a faker and a pseudo scientist without technical ability or education, but with a clever bent for sensationalism and commercialism. The facts are that Marconi, by the year 1894, had studied under such notable educators as Professor Rosa, and that he had specialized in physics and had familiarized himself with all that had been done in electromagnetic waves. Furthermore, Marconi's earliest patent application shows not only great creative ability and inventive ingenuity, but that he had a firm grasp of the fundamental principles of electricity. It is true that Marconi made the fullest use of the inventions of Hertz, Branly, and others, to whom he has given full credit in his own papers, but in the adaptation of these devices to a workable wireless telegraph system, he made many improvements. No better proof of this can be found than in the statement of Professor Slaby, who, though he himself had been working on the problem of Hertzian wave telegraphy, frankly admitted after witnessing Marconi's first public demonstration in England, that Marconi had succeeded where he had failed.

Very recently a claim has been put forward by the Russian Soviet to the effect that Prof. Alexander Popoff was the inventor of wireless telegraphy. In an interview relative to this, Marconi stated, "The Soviet's claim was never once put forward by Professor Popoff himself. When I was in Petrograd in 1902 Popoff sent me a telegram—'Greetings to the father of wireless.'"

Marconi brought wireless telegraphy to America in 1899, in which year he reported the races for the *America's* cup. Prior to this, little had been done with electromagnetic wave telegraphy in this country, and we have few claimants to the honor of inventing wireless telegraphy. In 1901, on the occasion of the next series of races for the *America's* cup, no less than five American wireless companies were engaged in attempting to report the races, and by one of these companies Mr. Marriott was eventually employed. Mr. Marriott was not one of the pioneers of the art in America, though he has been connected with its development for a long time, long enough to know more about the history of the development than his article would imply. Among those whose names stand out prominently in the commercial development of wireless telegraphy in this country, are those of Fessenden, Stone, Massie, Shoemaker, and DeForest. These were the American pioneers.

In submitting these remarks, it is in the belief that the high standard of RADIO BROADCAST can only be maintained by fair and square shooting, and it is with the hope that you will make an effort to ascertain and publish the facts relative to the question at issue. I personally resent the slur on the good name of Mr. Marconi, the founder of the art which has been my livelihood for more than sixteen years, and I am sure that many other workers in the field must feel the same.

Very truly yours,
M. E. PACKMAN,
Valparaiso, Indiana.

Who Said Bad Reception?

WE HAD firmly made up our minds that the season which is quickly fading into the dim past was about the worst on record, as far as radio reception conditions are concerned, when into our midst flutters the following letter.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

No doubt you have received during the past winter many complaints from radio fans about poor reception, but in this connection I am glad to report my reception for the first year in which I have possessed a receiver, to be very good. I purchased in August, 1925, a five-tube receiver (factory built), and installed it in my home in Philadelphia. I use a ¼" wide copper tape antenna, about fifty feet long (single wire), and my lead in is about twelve feet long. My receiver is located on the second floor, and it is grounded to a tin roof, which is about twelve feet square. The ground wire is about five feet long, and is soldered to the tin roof.

I have tuned-in about two hundred stations, representing 31 states in the United States, together with Cuba, Mexico, and Canada, and have received proof of reception from 180 Stations, including, KFI, KGO, KPO, CZE, WFAA, PWX, 6 KW, KOA, CNRA, CFCA, and many others. I have tuned-in several 100-watt stations from St. Louis, Florida, and New York. I have received KOA as early as 10 P. M. (E. S. T.), and KFI at 12:00 midnight, and PWX and 6 KW around 10 P. M. I had CZE one night in January about 10:30 P. M. (E. S. T.). The greatest number of stations I have tuned-in in any one night is 77 (from 7 P. M. to 2 A. M.). The following is a list of some of the stations from the various states: 26 from New York, 23 from Illinois, 10 from Missouri, 3 from California, 4 from Texas, 20 from Pennsylvania, 7 from Iowa, 10 from Ohio, 9 from Florida, 8 from Canada, 3 from Wisconsin, 10 from Michigan, 12 from New Jersey. I can prove reception of these stations, both by letter and by verification stamp. All stations were received on the loud speaker.

I think this is very good reception for what is known as a poor radio receiving year, and think I can do much better, if conditions are more favorable, next winter.

Yours very truly,
C. M. REBOK,
Philadelphia, Pennsylvania.

INDEX TO ADVERTISERS

IN THIS ISSUE

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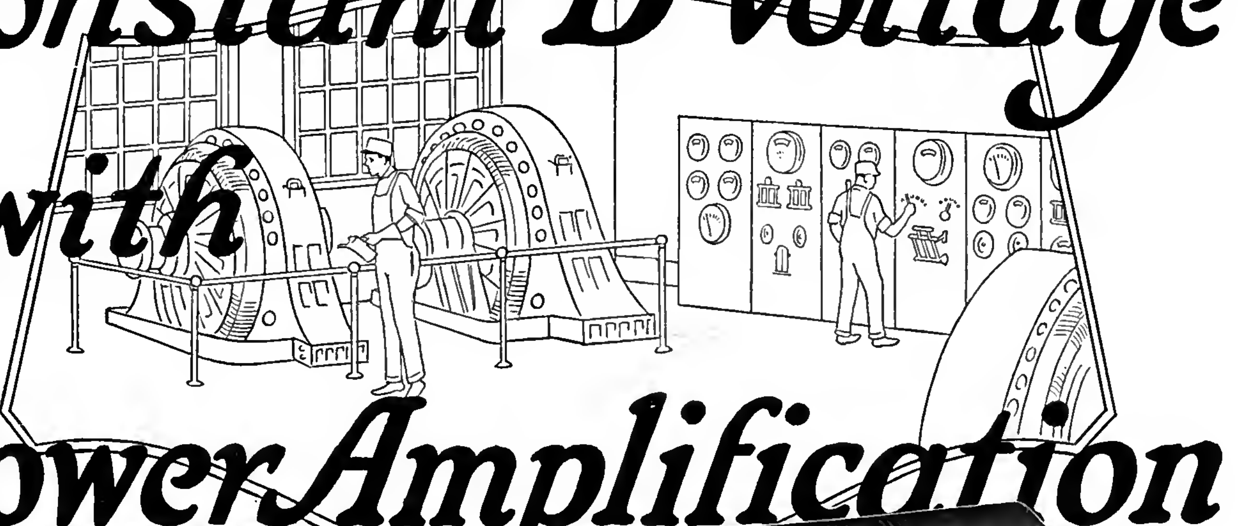

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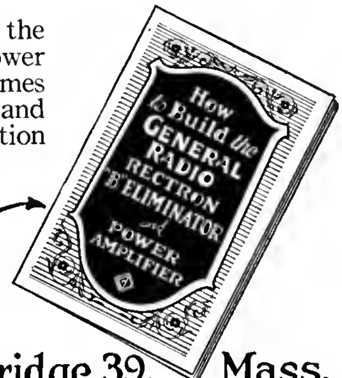

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Behind the Panels of Better Built Sets

RADIO BROADCAST

WILLIS K. WING, Editor

AUGUST, 1926

KEITH HENNEY
Director of the Laboratory

JOHN B. BRENNAN
Technical Editor

Vol. IX, No. 4

CONTENTS

BEHIND EDITORIAL SCENES

AMATEURS all over the country have been writing to know what has become of the RADIO BROADCAST-Eveready Short-Wave receiver contest to find a good nonradiating short-wave set. Due to causes beyond our control, the selection of the prize-winners has been delayed, but an announcement about the contest appears on page 332, and the selected receiver will be described in our September number. Austin Lescarboura tells in that number how much it costs to broadcast. "Courtesy" programs—a most interesting development—are really paying for broadcasting and this story tells how.

B. L. SHINN, of the Vigilance Committee of the Associated Advertising Clubs of the World tells on page 292 some surprising facts about misleading sales and advertising practise in marketing storage batteries. It will help every radio purchaser to get most value for his money to read this article. We are proud to present, on page 300, the story of Dr. G. W. Pickard's interesting work on measuring the variation in radio signal strength. Doctor Pickard's careful experiments are some of the most interesting and most important now going on in the radio field, and this first of two articles about his work is an exclusive announcement. Kendall Clough, of the Research Laboratories of Chicago, describes a local receiver which will give great satisfaction to the city-dweller, intent on beautiful reproduction of his local program. This receiver is another version of the set described in our May number. The other articles in this number are of more than usual interest.

MUCH favorable comment has come into the office on the RADIO BROADCAST Laboratory Data Sheets, which started with the June issue. They will be a regular and, we believe, a very valuable feature of the magazine. Since we appeared in our enlarged size with the November, 1925, issue, many readers have complimented us on our policy of not "running over" the articles which appear in the main text section of the magazine. That practice, a distinct help to the reader, is exclusive with this magazine and will be continued.

THE September RADIO BROADCAST will contain in addition to the details of the prize-winning short-wave receiver, a description of the Browning-Drake circuit employing impedance amplification plus some interesting refinements. This Browning-Drake model will please the many correspondents who continually write us for instructions on how to build the circuit with this system of amplification. RADIO BROADCAST described that popular circuit first, in December, 1924. Many other interesting and important technical articles will be a part of the Septembe magazine, as well.

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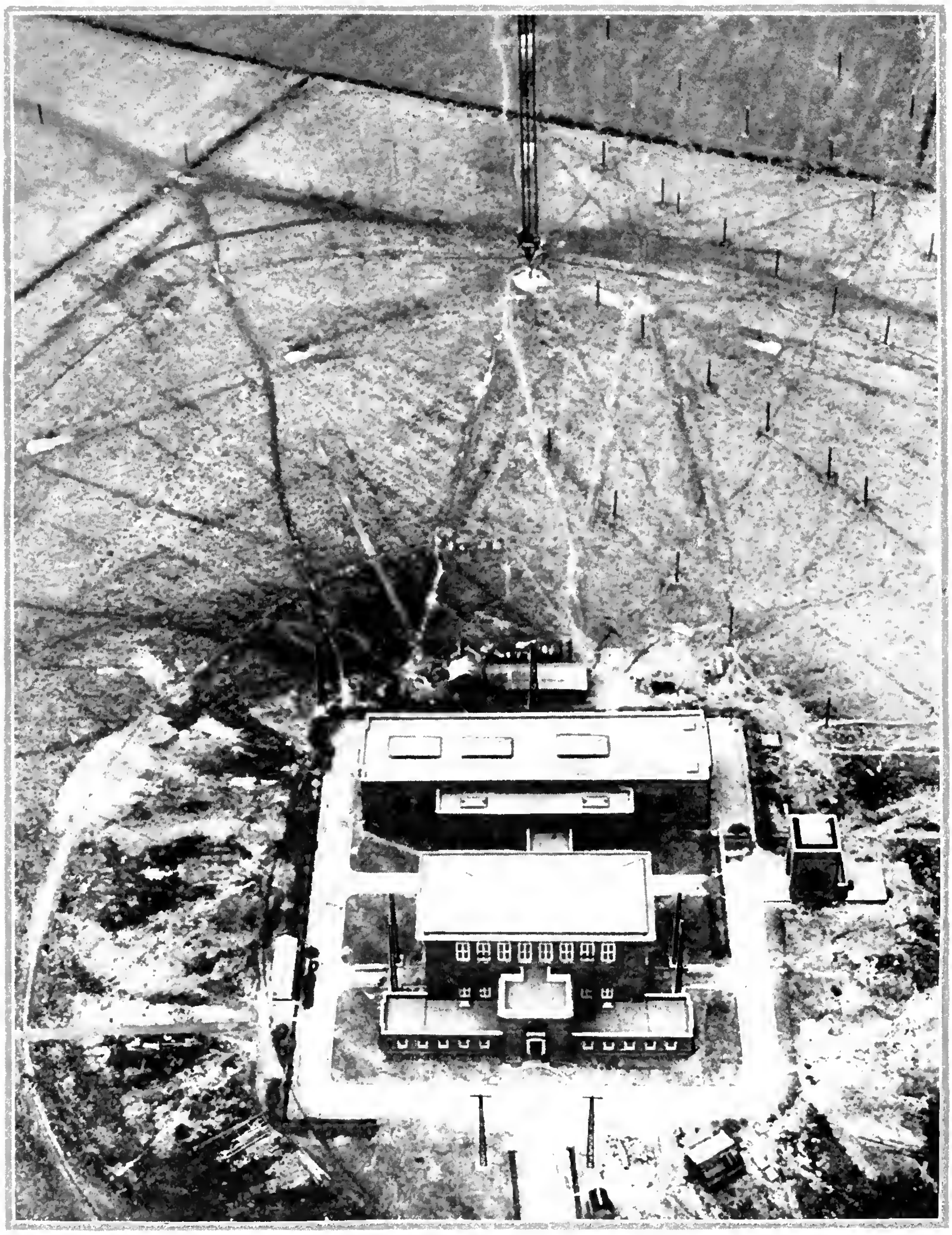


LOOKING DOWN ON THE NEW RUGBY STATION

Nine-hundred acres of land are devoted to the masts and station houses of this new world-wide British station. Five-hundred kw. in the antenna is generated by means of water-cooled tubes. The main masts are 820 feet high, and are provided with elevators to carry three men. Here is located the British transatlantic telephony transmitter, the signals of which have been heard in Australia

RADIO BROADCAST

VOLUME IX NUMBER 4

AUGUST, 1926

One Billionth of a Meter

The Sun Transmits Light Waves with Three-Hundred Billion Kilowatts' Power —Röntgen's Discovery of the X-ray in 1895, and Laue's Experiments Twenty Years Later—How the Theory of the Structure of Crystals Was Proved —The Work of the Braggs, Coolidge, and Moseley—"Atomic Number"

By JAMES STOKLEY

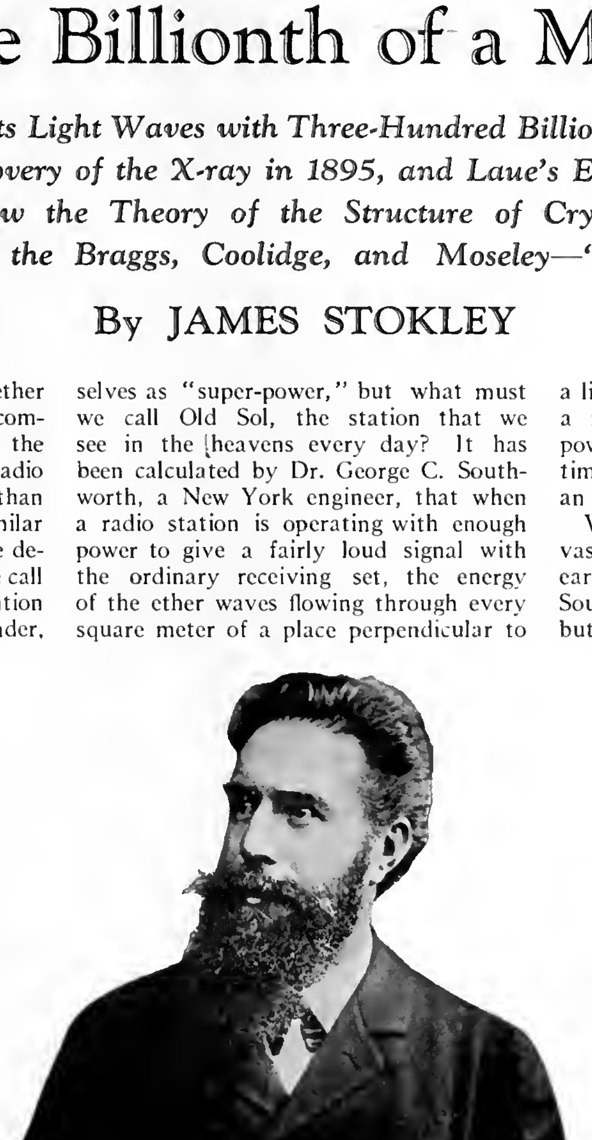
IT IS a long step from the long ether waves used in intercontinental commercial radio communication to the shortest waves now used for radio purposes, but just as much shorter than these latter are those ether waves, similar in nature to our radio waves, which we detect by means of the eye, and which we call light. Radio is such a recent invention that people still look on it with wonder, yet if they look at a star in the heavens, such as the brilliant Sirius, the "Dog Star," which shines in the winter sky, or even at the sun itself, it causes them no wonderment, but instead, they take it as a matter of course because they are used to it.

Yet the waves which make us aware of the presence of the sun, or Sirius, are like those used in radio, except that they are shorter in length, and hence vibrate more rapidly. And the distances they travel make the range of the most powerful broadcasting station seem insignificant in comparison, for the light waves from the sun travel about 93,000,000 miles before they reach us; those from the star Sirius come something like fifty trillion miles before we see them—so far that though ether waves travel fast enough to encircle the earth seven times in one second, the light from Sirius keeps on its journey for eight and a half years in order to cross the gap separating the star from us. And Sirius is one of the nearest of all the known stars!

And then there's the question of power. Broadcasting stations of fifty kilowatts refer to themselves as "super-power," but what must we call Old Sol, the station that we see in the heavens every day? It has been calculated by Dr. George C. Southworth, a New York engineer, that when a radio station is operating with enough power to give a fairly loud signal with the ordinary receiving set, the energy of the ether waves flowing through every square meter of a place perpendicular to a line to the station is about a quarter of a microwatt—such a small amount of power that one hundred and sixty million times as much would be required to light an ordinary 40-watt electric lamp.

With the sun, however, the power is vastly greater, for each square meter of the earth's surface receives, according to Dr. Southworth, not a fraction of a microwatt, but about one and a half kilowatts, enough power to light all the lamps in a good sized building, and about six billion times as much power as from the broadcasting station! And this in spite of the fact that the sun is more than ninety million miles away!

A little better for man's handiwork is the comparison of receiving sets. Nature provided each of us with two of these capable of detecting ether waves when she gave us our eyes, but, though man has not been able to compete with the sun in the matter of transmitters, he has developed a better receiver than the eye as regards sensitivity. While a receiving set may readily be constructed that will respond to an electric field of five-hundred millionths of a volt per meter, as electrical field strength is measured, the eye will not be aware of any sensation of light unless the energy is the equivalent of an electric field of forty-three millionths of a volt per meter. The best radio set is therefore nearly a thousand times as sensitive as man's eye.



WILHELM KONRAD RÖNTGEN

A German physicist of Wurzburg, who, in 1895, discovered what he termed "X-rays" on account of their then enigmatical nature. It was some twenty years later before a fellow countryman of his, named Laue, solved the problem of "X," the unknown quantity

THE DISCOVERY OF THE X-RAY

BUT just as much shorter than the light waves as they themselves are shorter than the radio waves, are the vibrations which enable man to look into his own body, or into the interior of molecules of which matter is made to study the structure of the atoms themselves. These are the X-rays.

Despite the value that X-rays have proven to possess, it was only about thirty years ago that Wilhelm Konrad Röntgen made their discovery in his little laboratory at Wurzburg, Germany.

In his interesting book, "Light, Visible and Invisible," the late Prof. S. P. Thompson quotes Röntgen's own account of the birth of the X-rays.

"There is no history," said Professor Röntgen, when asked to tell of the history of the discovery. "I had been for a long time interested in the problem of the cathode rays from a vacuum tube as studied by Hertz and Lenard. I had followed their and others' researches with great interest, and determined, as soon as I had the time, to make some researches of my own. This time I found at the close of last October (1895). I had been at work for some days when I discovered something new."

"What was the date?"

"The 8th of November."

"And what was the discovery?"

"I was working with a Crookes' tube covered by a shield of black cardboard. A piece of barium platinocyanide paper lay on the bench there. I had been passing a current through the tube, and I noticed a peculiar black line across the paper."

"What of that?"

"The effect was one which could only be produced, in ordinary parlance, by the passage of light. No light could come from the tube because the shield which covered it was impervious to any light known, even that of the electric arc."

"And what did you think?"

"I did not think; I investigated. I assumed that the effect must come from the tube, since its character indicated that it could come from nowhere else. I tested it. In a few minutes there was no doubt about it. Rays were coming from the tube, which had a luminescent effect upon the paper. I tried it successfully at greater and greater distances, even at two meters. It seemed at first a new kind of light. It was clearly something new—something unrecorded."

"Is it light?"

"No." (In this answer he was mistaken.)

"Is it electricity?"

"Not in any known form."

"What is it?"

"I do not know. Having discovered the existence of a new kind of rays, I of course began to investigate what they would do. It soon appeared that they had penetrative power to a degree hitherto unknown. They penetrated paper, wood, and cloth with ease, and the thickness of the substance made no perceptible difference, within reasonable limits. The rays passed through all the metals tested, with a facility varying, roughly speaking, with the density of the metal."

And so Röntgen made his discovery, describing it first in a scientific paper entitled "Ueber eine neue Art von Strahlen" ("On a New Kind of Rays"), published in the proceedings of the Wurzburg Physico-Medical Society.

AN X-RAY PICTURE OF A BOUQUET

The three center flowers are tulips, while the others are jonquils. Note the developing masses of seeds in the ovules of the latter flowers, and also the faint outline of the leaves in the lower corners of the picture

But Röntgen was mistaken when he said that the rays, which he named X-rays because he did not know what they were, were not light. True, they were not light as he knew it, for when he tried to reflect the rays from a mirror or refract them through a lens, their paths were not disturbed. Surely if they were light they could be reflected and refracted!

How easily someone else might have anticipated the German scientist is shown by the fact that as soon as his discovery was announced, physicists in dozens of laboratories the world over immediately began to repeat his experiments and to take X-ray photographs. Crookes tubes, such as Röntgen used, were rather common pieces of laboratory equipment; so were fluorescent screens, but no one had happened to observe the effect when a tube in operation was separated from a screen by a piece of apparently opaque material, or, more important, if they had noticed it, unlike Röntgen, they did not investigate.

THE EXPERIMENTS OF LAUE

NOT for nearly two decades later was the "X", the unknown quantity in the X-rays, to be solved. A fellow countryman of Röntgen's, Prof. M. Von Laue, of Munich, suggested that the X-rays were the same as the rays of light, but very much shorter in wave-length, so short that mirrors, prisms, or lenses, which turned ordinary light rays from their path, had no effect on the X-rays. Neither did the finest available diffraction grating have any effect. This latter consisted of a piece of glass on which were ruled parallel lines as close as 15,000 to the inch, and which spread a beam of white light out into a spectrum in much the same way as a prism.

It occurred to Laue that if he had a grating as much finer as the ordinary grating as he supposed the X-rays waves to be shorter than light waves, he might succeed in bending them, but such a grating seemed impossible, as the finest that had ever been ruled had only about 30,000 to the inch.

The accepted theory of the structure of crystals stated that the molecules of which

ATOMIC ARRANGEMENT IN SOLID BODIES

Is indicated by these atomic models which, of course, are magnified millions of times. From left to right, the models represent the diamond, magnesium, and calcite

a crystal were made were arranged in successive tiers, layer cake fashion, each layer being one molecule deep. Laue thought then, that he might obtain his grating by using the molecular planes of a crystal.

At his suggestion, two of his colleagues, Friedrich and Knipping, tried this, and were successful, thereby killing two birds with a single experiment, for not only did they show that the X-rays were actual forms of wave motion, but also that the structure of the crystals was the same as theory had predicted. Three years later, two English physicists, Sir William Bragg and his son W. L. Bragg, collaborated in a very careful and exhaustive series of experiments which culminated, in 1915, in the publication of their book "X-rays and Crystal Structure," and which won for them the joint award of the Nobel prize in physics the same year.

From this beginning there developed a new method of studying X-rays. Just as the invention of the spectroscope by Fraunhofer, in 1814, enabled scientists to study light in a way they had been unable to do before, so did the work of Laue, and the Braggs, which led to the X-ray spectrometer, lead to new methods of studying materials of all kinds as well as the X-rays themselves. Resembling the optical spectroscope, except that a crystal of rock salt replaces the glass prism, many laboratories are now equipped with the X-ray spectrometers as an aid to analysis. In fact, this instrument is now manufactured and carried in stock by one large manufacturer, even though it was only a very few years ago that the first crude form was invented.

All solid metals consist of crystals, and so, though the work of Laue and Bragg might not have seemed at that time to have any practical value, it has now opened tremendous possibilities in metallurgical research. The way the atoms and molecules are put together is just as much a characteristic of a metal, and just as important, as its density or melting point; indeed, it is the arrangement of the atoms that determine its physical properties.

For example, metals, like human beings,

A PORTABLE X-RAY OUTFIT

It is used to produce diffraction patterns from crystals. A narrow pencil-like beam of the rays is permitted to pass through the crystal, after which it emerges in a spread-out condition. It is thrown onto the small screen, and is visible as a series of rings of spots

show fatigue. A piece of brass may be bent a certain number of times before it breaks, but after it has been bent a hundred times, though it may have its surface polished, and look the same as a fresh piece on the outside, it will not be nearly as strong. By the use of the X-ray spectrometer, however, the difference in the lines in the photograph shows a great difference between the fresh piece and the one that has been fatigued, for the one shows the lines sharp and distinct, while in the other they are hazy and ill defined.

Such studies have shown why steel, and various alloys, are stronger than iron, or, perhaps, than any of the metals of which they are made. In such metals as aluminum, silver, copper, and gold, X-ray studies indicate that they consist of closely packed atoms, the plan of the crystal being simply the direction in which the packing is most dense. If it breaks, it does so most easily along one of these planes, but if the metal consists of a mass of crystals, rather than a single one, the planes of weakness lie in different directions, and so it is not so easy to break. Now, if a number of atoms of another substance are mixed with them, as carbon atoms in steel, which apparently tend to fill up the interstices between the iron atoms, they lessen the possibility of the atoms slipping over each other, and the mixture is harder than either iron or carbon.

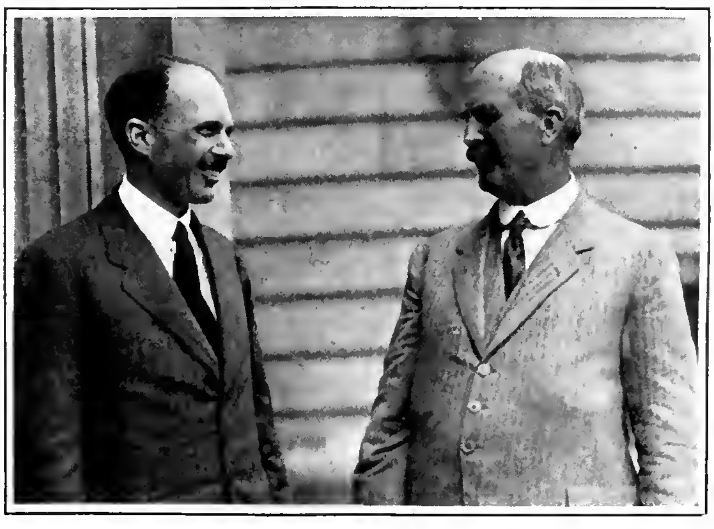
HOW THE X-RAY TUBE WORKS

THE ether vibrations called X-rays result when cathode rays—rapidly moving electrons produced when a high-tension electric current is passed through a highly evacuated tube—are suddenly stopped. In the Crookes tube, which produced these rays, and which Röntgen was using when he made his discovery, the cathode rays are stopped by the glass wall of the tube, but early in the history of X-rays it was found that if the cathode rays were focussed on a target of a dense metal, such as platinum, far more copious amounts of the rays were produced.

There was another advantage in focussing the rays on such a target, for the X-rays all radiate from a small point,

PROF. AND SIR WILLIAM BRAGG

Father and son. Professor W. L. Bragg is of the University of Manchester, England, while Sir William is of the Royal Institution, London. They were jointly awarded the much coveted Nobel prize for physics in 1915



DOCTOR W. D. COOLIDGE

He is the inventor of the Coolidge X-ray tube, and is shown at his desk in the Research Laboratory of the General Electric Company, examining one of the latest types. In the background may be discerned a collection of tubes likely to make any X-ray expert envious

while in the tube that Röntgen used, their source was a large area. The X-ray photographs of bones in the body are only shadow pictures. They are similar to those that we might obtain of a person's head by standing him beside a large photographic film and then allowing light to fall on the person so that a silhouette of his head was on the film. If the source of light was a large north window, the shadow would not be as distinct as if the illumination came from a small concentrated source, such as an electric arc. In the same way, X-rays from a small source give more distinct photographs than if they came from a larger surface.

But all the early X-ray tubes were more or less erratic in behavior. The penetrating power of the rays—the hardness, as it is called, depends on the degree of vacuum in the tube, and too little gas left in was almost as bad as too much, if the most satisfactory results were to be obtained. In some of the various tubes that were constructed, elaborate devices were used to allow the degree of vacuum in the bulb to be changed.

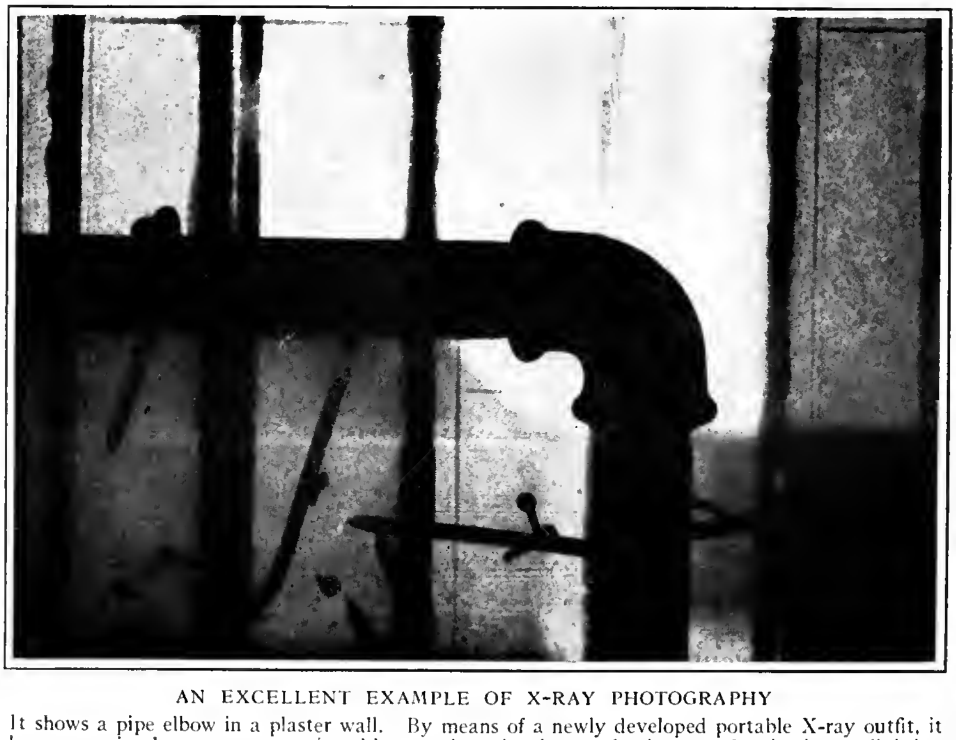
However, in 1913, Dr. W. D. Coolidge, now assistant director of the Research Laboratory of the General Electric Company, designed the form of tube which now bears his name. In this tube, advantage is taken of a fact familiar to every radio fan, namely, that a hot filament in an evacuated bulb gives off electrons. This makes possible the operation of radio tubes, and it also has made possible the most satisfactory source of X-rays ever devised.

In the Coolidge tube there is an extremely high vacuum, about a hundred times as high as in the older forms, and so high that an electric discharge will not pass through it in the ordinary manner. The cathode, however, consists of a small coil of tungsten wire—a filament, and when it is heated by the ordinary lighting current, it emits electrons. The higher the voltage, and the hotter the filament, the more copious are the electrons. Thus, adjusting a rheostat has the same effect that changing the vacuum had in other tubes. Resembling the radio vacuum tube, the Coolidge X-ray tube has two sources of current, for besides the relatively low voltage used for heating the filament, a high tension current is used to drive the electrons to the heavy tungsten target and produce the X-rays. Because of its convenience and reliability, the Coolidge tube has largely replaced other forms in medical and physical laboratories.

However, while platinum was used in the earlier forms of X-ray tubes as the target from which the rays emanate, and tungsten is used in the Coolidge tube, numerous other substances may be employed, and by analyzing the radiations from various kinds of targets with the aid of the crystal of the X-ray spectrometer, exact characteristics of the elements used as targets may be determined. Elements are now classified by chemists (and physicists too, for the boundary between physics and chemistry, formerly so distinct, is fast disappearing) according to their atomic number, from one to ninety-two.

EXPLAINING "ATOMIC NUMBER"

THE atomic number of an element is simply its order in the procession of elements when arranged according to the weight of their atoms. They have been compared to a flight of 92 steps, hydrogen being number 1 and uranium number 92, but one step may be occupied by more than one element, while one element may occupy more than one step. This is due to isotopes, which are forms of the same element of slightly different atomic weight. In our high school chemistry we learned that the gas chlorine, for example, had an atomic weight of 35.5, but this is really the average atomic weight of all its atoms, some of which may be 35, and others 37. In the case of some elements, whose previously accepted atomic weight was a whole number, as oxygen, of atomic weight 16, there are no isotopes, but all the atoms weigh the same. However,



AN EXCELLENT EXAMPLE OF X-RAY PHOTOGRAPHY

It shows a pipe elbow in a plaster wall. By means of a newly developed portable X-ray outfit, it becomes a simple matter to examine objects such as the above. In the case of a pipe in a wall, it becomes unnecessary to tear down a large section of the wall to find the damaged section the atomic number refers to the average, so chlorine is number 17 and oxygen number 8.

Among the early workers in the subject of X-ray spectra was a young Englishman named Henry G. J. Moseley, who worked with Sir Ernest Rutherford, then at Manchester, and at Oxford University, his Alma Mater. One of his experiments was to test with the X-ray spectrometer the X-rays with different substances as targets. This led him to the important discovery, at the age of 25, that the spectra of the X-rays from different elements were remarkably similar in regard to the position of their dark lines, but with the difference that the wavelength of the radiation which corresponded to the lines becomes shorter as the atomic number of the element increases. For example, nickel being number 28 and copper number 29, the position of the lines in the copper spectrum shows them to be of slightly shorter wavelength than in the spectrum of nickel.

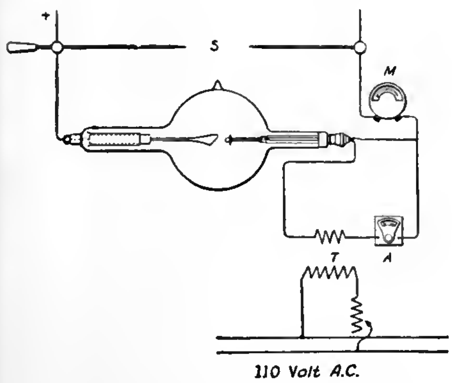
In the summer of 1914, after he had made this discovery, Moseley went to Australia to attend the meeting of the British Association for the Advancement of Science, and to tell them of his work. August came, and with it the outbreak of the World War, and Moseley hurried back to England and joined the Royal Engineers. He was soon in the thick of fighting and on August 10, 1915, was in the Gallipoli campaign, when a Turkish bullet ended the life that had already made such great contributions to science and which had given every prospect of many more. The work he began has already led to brilliant discoveries in the hands of his successors. Since each element has its characteristic X-ray spectrum, and since the wavelength of the lines varies according to the atomic number, a single X-ray spectrum photograph gives an infallible means of identifying the element. Not only is the method applicable to already known elements, but as blank numbers are left for ones which have still been undiscovered, the presence of a hitherto unknown element may be demonstrated as easily as one that is already common.

Until about a year ago, there were five empty ranks in the parade of elements. Since then, three have been filled. Numbers 43 and 75 were filled by Dr. Walter Noddack and his associates, working at the University of Berlin. They concentrated solution of ores containing platinum, and when their X-ray spectra showed the lines in the positions corresponding to their numbers, according to Moseley's law, they knew they had found the new elements, and named them Masurium and Rhenium. Still later, Dr. S. B. Hopkins, at the University of Illinois, found number 61, which he named Illinium after his college, and with it, too, the X-ray spectrum corresponded precisely to Moseley's law.

Elements number 85 and 87 are still absent and unaccounted for, though we know what their X-ray spectrum will be when they are discovered.

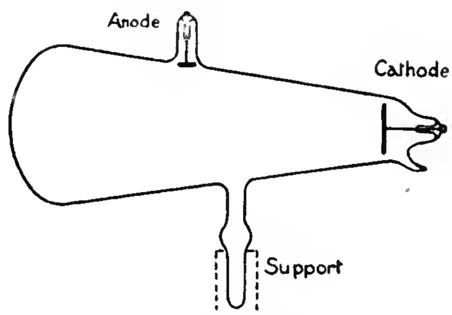
X-RAY DIFFRACTION APPARATUS

It is used for obtaining X-ray spectra from which the arrangement of the atoms in metals and other solids may be determined



COOLIDGE X-RAY TUBE WIRING

As is the case with the ordinary radio vacuum-tube circuit, an electron flow is emitted from the filament. To the cathode of the Coolidge tube, which corresponds to the filament in the radio tube, is applied an 110-volt current. A high-voltage current from a transformer also flows through the tube and, as the electrons bombard the tungsten target, X-rays are produced



AN EARLY X-RAY TUBE

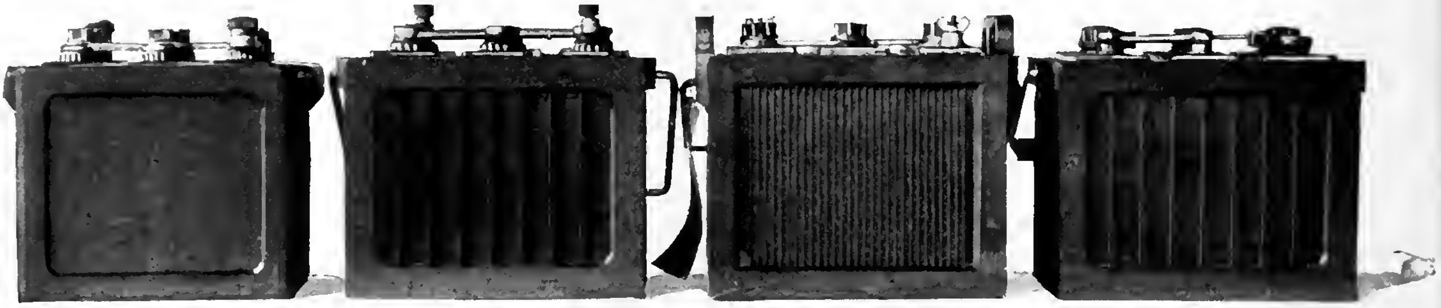
This was the type employed by Röntgen when he discovered X-rays. The cathode rays impinged on the broad end of the tube

THIS SCALE HAS BEEN SPECIALLY DEVELOPED FOR MEASURING X-RAY SPECTRA

As seen here, it is being used with two spectrum photographs. The upper photograph is of the tungsten spectrum while the lower one is of ordinary table salt. The numbers on the scale indicate the wavelengths of the rays in 250/1,000,000ths of an inch.

How Is Your A Battery?

Which Explains Why All A Batteries are not Always What They Seem—When Buying an A Battery, Look for the Rated Ampere-Hour Capacity—Products of Nationally Known Manufacturers Can Be Relied Upon



WHICH A BATTERY WOULD YOU BUY?

The first and fourth batteries above are rated at 100 amperes and will deliver it. The second was sold as a "140-ampere" battery and when tested, gave but 80 ampere-hours. The third was labeled "amp.-hours 120", and a test showed it would deliver but 75 ampere-hours

By B. L. SHINN

National Better Business Bureau

WHEN you flip your radio switch this evening, will each tube be warmed with its normal filament voltage and kept that way until you shut off the set? Or will you wonder all evening whether the last charge you gave your battery is going to last until next Sunday? When you bought your battery, did you get the *ampere-hour capacity* you were led to expect? Do you know how to get it in the next battery you buy?

The *ampere-hour capacity* of an A battery is a factor of vital importance in the satisfactory reception of radio broadcasting—and for any other services as well. True, the discharge of the battery is but a fraction of what is used in the starting or lighting of an automobile. But, as radio sets are not yet equipped, like automobile motors, with generators for recharging, and as the average fan's enthusiasm leads to many hours' usage each week, enough *ampere-hour capacity* to service the set without too frequent recharging is essential.

When the radio public became an important market for storage batteries, the leading battery manufacturers produced batteries especially designed for radio use to give a relatively low discharge over a long time period. The first of these batteries which appeared were often rather cumbersome affairs. This created the impression among many fans of little technical knowledge that the brute size of a battery is at least one indication of the number of hours of service which it will give. While the manufacturers already in the field strove to fit the design of radio storage batteries into cabinets of reasonable size, while retaining maximum *ampere-hour capacity*, a host of newcomers invaded the field of storage battery manufacturing. In this field, as in others, fair competition has usually the effect of spurring on the improvement of the product and of its advertising, marketing, and servicing. As in other fields, however, unfair competition, once it appeared, threatened at one time to play havoc generally with the selling of radio storage batteries.

IT SHOULD be said that, without major exception, the radio manufacturers that you and I are apt to have dealings with are entirely reputable and have no thought but to give the consumer his money's worth in radio products. They believe that good merchandise should be exchanged for good money. But like all large and growing business, radio has had its camp followers—its unprincipled fellows who prefer to "get away" with something than to do the job properly. Through the coöperation of the National Better Business Bureau, RADIO BROADCAST, *in its August, 1924, and February, 1925, issues, published the first information on how tubes and sets were being misbranded and sold dishonestly. Now, we have the privilege of presenting information of importance to every battery buyer. Readers who know of dishonest selling practices, such as outlined in this story, will confer a favor by writing to either* RADIO BROADCAST *or to the National Better Business Bureau.*—THE EDITOR.

Numerous battery assemblers, with not even a reputation to lose, exploited the radio fan's innocence of storage battery construction by placing very few plates and correspondingly small quantities of active material in very large boxes, and either misbranding these "hope chests" with much higher capacity ratings than they possessed, or selling them unbranded to the type of dealers who take advantage of such a product to misrepresent it on their own account. Using a very small number of plates, frequently of poor quality, these concerns were able to undersell by several dollars any legitimately rated battery in the market.

Some of the older battery makers, although but for a brief interval, succumbed to the economic stress of this manifestly unfair type of competition. Picture to yourself the "gyp" getting the business with veritable junk, the honest product lagging on counter and shelf while radio fans scramble for spurious "bargains." Some companies, for a short time, were thus led to overrate the batteries which they had designed for radio use. Others, while maintaining a fair degree of accuracy as to the batteries sold under their *own* trade mark, manufactured for jobbers batteries made up in oversize boxes, some of which were misbranded as to *ampere-hour capacity*, and some of which were unbranded.

The effect of such practice is visualized for you in the illustration which heads this article. Just as most radio fans could not tell without the caption under this picture which of these batteries truly have a capacity of 100 ampere hours, so most of you might be similarly confused by the batteries themselves. The two whose actual capacity is far below 100 ampere hours were rated 120 and 140 ampere hours. One was so marked by the maker. The other was made up oversize and unbranded, and the high amperage was claimed by the retailer.

The spread of the oversize box, misbranded and unbranded, would soon have meant chaos in the marking and selling of storage batteries for radio use. It had arrived in a comparatively short interval of time, and was allowed to develop no further than enough to demonstrate its unfairness and its destructive character, whereupon it was quickly and effectively dealt with.

THE CONSUMER FINDS A CHAMPION

THE National Better Business Bureau is an organization maintained by national advertisers to protect the consumer, to promote fair play between seller and buyer, and to protect industry from the usually unfortunate sequel of such developments as we have just described. Affiliated with forty Better Business Bureaus operating locally in the retail field, it has an unusual bird's-eye view of what is happening to an industry and to its consumers. For several years the National Bureau has had intimate contact with the storage battery industry in connection with the advertising, marketing, and servicing of automotive storage batteries. The development of the radio storage battery market was carefully watched by the national staff and its local contacts. When the seriousness of the situation became apparent, the National Bureau urged the industry to coöperate in a house-cleaning. A number of leading manufacturers agreed to the suggestion enthusiastically and instantly.

"But before we can make headway," said the National Bureau, "in eliminating the 'gyp' battery and the box of junk sold for radio use, the leaders in storage battery manufacture must set the example for the entire trade by cleaning house themselves."

The radio battery merchandising code reproduced above on this page was offered to the industry as the first step in the protection of the radio battery user and the establishment of the whole trade upon a four-square basis. Within a few weeks, the makers of 85 per cent. of the storage battery production of the United States had pledged themselves to follow such a code.

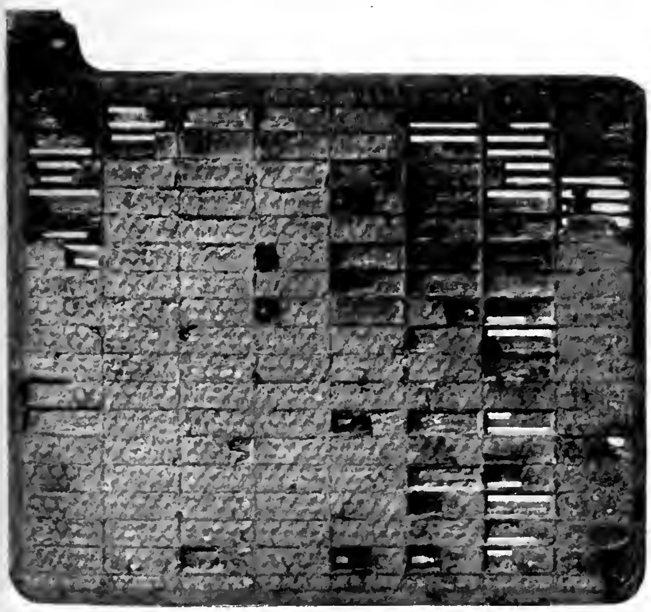
> **Code for Merchandising Storage Batteries for Radio Use**
>
> 1. Make sure that every battery is appropriately and correctly rated.
> 2. Brand each battery with the correct rating figure, or with maker's name and type or symbol number from which the rating may be determined. Preferably this branding should be on the box itself, at least on the name plate or other exposed part.
> 3. In each catalog or piece of advertising matter, advise dealers of the rating method employed and what any type or symbol numbers used may mean.
> 4. Decline to misbrand batteries made for others, or to deliver batteries in oversize boxes unless marked with correct capacity rating in plain figures.
>
> NATIONAL BETTER BUSINESS BUREAU, INC.
> 383 Madison Avenue
> New York City

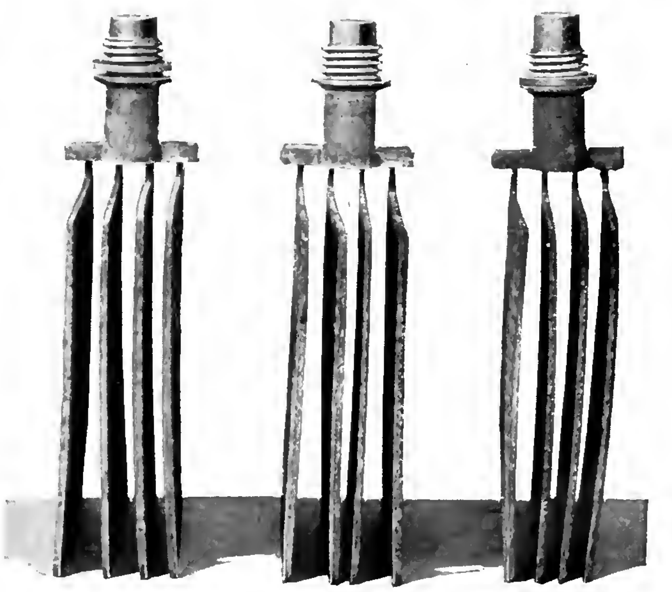
The National Better Business Bureau then turned its attention to the battery makers who had not voluntarily placed their marketing upon a fair basis. Numbers of these were approached regarding their practices. It was assumed in each instance that such a concern was perhaps unaware of the unfairness of the misleading custom of assembling and branding of batteries, and of the general clean-up which had taken place. Each was courteously invited to make over its method of marking and marketing so as to be fair to the consumer. A large number of those approached in this fashion saw the trend of events and revised their methods of representing batteries to the public in accordance with the suggested code.

A few chose to continue misbranding their products or putting up batteries in oversize boxes for certain types of retailers to misrepresent to their customers. Batteries were purchased from these concerns and tested by actual cycles of charge and discharge in the engineering laboratories of a nationally known institution. It was found that some of these batteries were marked and sold as and for products having a capacity nearly twice that recorded by the testing engineer. Batteries were photographed, inside and out, disclosing the useless additional clearance in each cell jar and the deceptive appearance of the box when placed beside batteries of the same rated capacity which would actually deliver the service for which they were rated. Other photographs, reproduced in this article, show the interior construction of some of these batteries.

In two bulletins, published in February and May, 1926, the National Better Business Bureau took to the trade and to the public these outstanding facts:

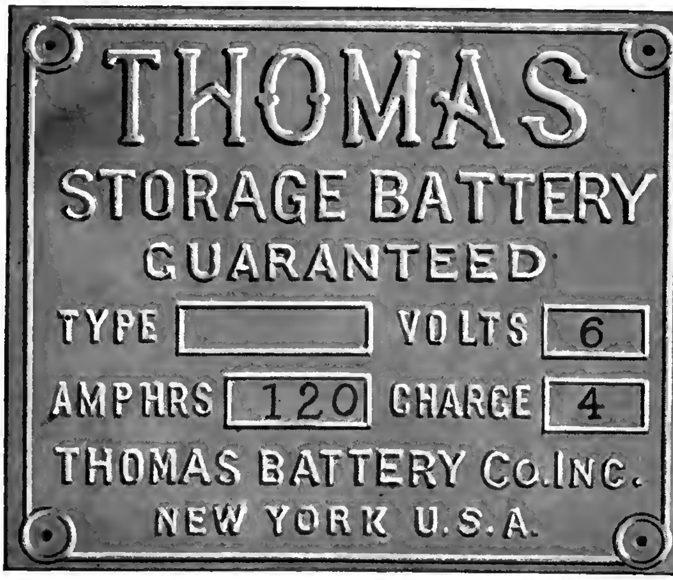
1. That *ampere-hour capacity* is the commodity which the radio user seeks in a storage battery.
2. That the size of the box alone is an untrustworthy indication of storage battery capacity.
3. That weight alone is likewise an unsafe guide to capacity.
4. That number of plates does not by itself determine the *ampere-hour capacity* of a radio battery.
5. That *ampere-hour capacity* depends directly upon the correct proportion of active available materials in the battery.
6. That the radio user *Can Play Safe* by buying the products of trustworthy manufacturers from trustworthy retailers, instead of looking for big boxes or heavy boxes of dubious parentage and indiscriminate distribution.
7. That the trustworthy manufacturer marks or identifies radio batteries so that the correct *ampere-hour capacity* may be readily learned by the consumer.





TWO ILLUMINATING EXAMPLES

Plates from a bargain battery after testing at radio rates. These plates were put in an oversize box, and the whole battery represented to be of a larger capacity than it could possibly be with the number and size of the plates. The positive plates were only one-tenth inch thick and after testing, the plates shed active material and warped. A battery like this is a poor one to make any filament glow—for long



MISBRANDING

Laboratory tests on the battery bearing this label disclosed the fact that its capacity did not actually exceed 75 ampere-hours

8. That the trustworthy retailer is eager to show the rating or identification on the battery and in the maker's catalog.

HELPING THE CONSUMER HELP HIMSELF

THE reception accorded these bulletins by the battery trade and the radio trade will be interesting to radio users. As an indication that many of those who serve the radio public take this subject seriously, we can record that the original edition of the first bulletin was snapped up inside of a week by battery makers, local Better Business Bureaus, and radio retailers in New York City. Sample copies of this bulletin were sent to battery service stations.

Do you think the service station man is not interested in straightforward radio battery business? The number of these men who ordered quantities of the bulletin "Buy Battery Capacity!" for distribution to their customers was so large that the second edition did not last much longer than the first.

Local battery dealers in Boston, Massachusetts, became sufficiently interested in the proposal to give the radio user an A battery which will deliver the *ampere-hour capacity* claimed for it for them to apply to the Boston Better Business Bureau and the Associated Industries of Massachusetts for a meeting on this subject, which was held with the representatives of seventeen concerns in attendance. Resolutions were passed pledging the adherence of those represented to the code, and urging the Boston Better Business Bureau to mop up any local misrepresentations which might remain. Philadelphia concerns in this field requested a similar meeting, which was held not long ago with like results. As this issue of RADIO BROADCAST goes to press, battery and radio companies in Chicago are urging a similar procedure there.

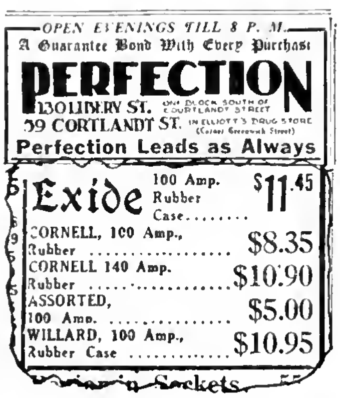
HOW TO GET MORE INFORMATION

ANY reader of RADIO BROADCAST who is interested in the subject may obtain a copy of "Buy Battery Capacity" without cost, by writing to the National Better Business Bureau at 383 Madison Avenue, New York City, and mentioning this magazine. The Bureau will also supply such inquiries with a copy of its May bulletin concerning a Philadelphia battery manufacturer whose career of misrepresentation had as its sequel an offer to his creditors to settle for twenty-five cents on the dollar. The significant subtitle of this bulletin is "Fair Play Has A Cash-Drawer Value." Both bulletins are written in simple and understandable language. They are intended as a guide to the battery user in obtaining products of the desired *ampere-hour capacity*, and as a warning to the trade that the apparent gains of "gyp" selling do not build permanent profits for any business.

The National Better Business Bureau has not concluded its service to the trade and to the public with the issuance of these bulletins. It expects to stay on the job until the radio public runs substantially no risk of encountering further deception of this type. It has the coöperation of the better publishers (both magazine and newspaper) in the form of effective self-censorship of their advertising columns and in the publication of such articles as this. (*Editor's Note.* Batteries, dishonestly marked, as explained by Mr. Shinn, have not been recommended by RADIO BROADCAST and would not, of course, pass the tests of our Laboratory). It invites the coöperation of the radio public. If you have found your A battery of suspiciously low *ampere-hour capacity*, notify the National Better Business Bureau, giving the maker's name and the time and place of purchase. In so doing, you are rendering a service to the thousands of new radio fans who purchase battery equipment every day.

ROOM TO SPARE IN THIS "HOPE CHEST"

From the outside, this battery looked quite all right, but the space for the proper number of plates was not completely filled. Note that an inch of space remains unused. Some manufacturers have followed this practice, which is hard for the layman to detect



NEWSPAPER ADVERTISEMENTS

How unbranded, oversize box batteries were represented in advertising. In the advertisement at the left the first and the last batteries in the list were not subject to investigation

THE MARCH OF RADIO

News and Interpretation of Current Radio Events

How Short Waves Are Linking Far Corners of the Globe

IN DAYS of old, the fading light of the last northerly port was the courageous Arctic explorer's last contact with civilization. Then followed months, usually years of cold silence. Just half a century ago, Sir Allen Young faced this dreariness in a mission of mercy. With him he carried a packet of letters for his compatriot, Sir George Nares; letters of home, of friends, of news, to break the cruel silence of the Arctic. These, by prearrangement, were left at Cape Isabella. MacMillan, several years ago, found this packet, unopened. And twenty feet away from it, he found another, records Young had buried before resuming his northward march.

What a change in fifty years. A dirigible whisks sixteen men skyward. A matter of hours, and they pass over the Pole. A newspaper correspondent clicks off a radio message to his sheet, where waiting men only hours later set up the type which crystallizes the achievement. The busy world soon forgets, but Sergeant Albert Payne will never forget. His Signal Corps radio station at Nome handled 22,000 words of press about the flight of the *Norge*.

The flight of the *Norge* has been the subject of thousands of words of comment, but not all the commentators have taken into consideration the fact that it was radio which mainly made it possible. The direction finding equipment was in constant use and gave important bearings to the navigators. Groping through the Bering Sea fogs, a chance signal from an Alaskan station told the navigators where they were and led to the successful landing of the ship at Teller, Alaska. The transmitting equipment of this ship, following the lines of present English practise, did not provide for short waves. They depended on 900 meters and 1400 meters (333 and 214 kc.) which worked successfully enough up to and over the Pole. But from the Pole to Alaska, the longer waves did not come through. One ventures to say that if the *Norge* had profited by the previous short-wave experience of others, the operators could have maintained constant communication.

The year 1926 is the year of explorations. Six expeditions will have penetrated the Arctic before July. At least two important expeditions will pierce the heart of South America. Francis Gow Smith, of the Museum of the American Indian, aided by native guides, is now going slowly up the River of Death, perhaps the most dangerous region in all South America. With him is a simple two-tube short-wave receiver. Signals from WGY's 32.79-meter (9140-kc.) transmitter were received by him with excellent volume at Corumbá, Brazil, almost 5000 miles from Schenectady. In the interior, the time signals and news broadcasts will prevent the silent forests from shutting off all contact with civilization. The receiver was designed and built by RADIO BROADCAST Laboratory.

By the time this magazine appears, the Dyott Expedition led by Commander G. M. Dyott under the auspices of the Roosevelt Memorial Association will have sailed for Brazil, to explore and photograph in still and moving pictures the territory first traveled by Roosevelt—the River of Doubt. Two complete radio stations will be set up, one at a base station above Corumbá, Brazil, and another portable set with the party. Short waves will form the link with the United States, and Commander Dyott hopes to send frequent dispatches back to the New York *Times*. His equipment is being built and operated under the direction of RADIO BROADCAST Laboratory.

Toward the last of June, two ships sailed to Greenland in the MacMillan expedition. The good old *Bowdoin*, commanded by MacMillan will lead, and the new schooner *Sachem*, newly built for this

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The top-of-page illustration shows the apparatus employed by the government to check up on broadcasters to see that they do not stray from their assigned frequencies

A RECORD-MAKING SHORT-WAVE RECEIVER

Francis Gow Smith (right), who is exploring the River of Death in central South America, photographed at the Explorer's Club, New York, with John B. Brennan, Technical Editor of RADIO BROADCAST. The short-wave receiver was designed and built by the RADIO BROADCAST Laboratory and loaned to Mr. Gow Smith. Special programs have been sent out by 2 XAF, one of the experimental stations of the WGY group, on 9140 kc. (32.79 meters) and have been received successfully by Mr. Gow Smith, who informed RADIO BROADCAST, "The radio created a positive sensation in Corumbá. Several of the most important people of Corumbá heard WGY programs on this receiver and were amazed at its clarity." Mr. Gow Smith is gathering material for the Museum of the American Indian and the American Geographical Society. Note the case which is built to stand rough handling and to contain the entire radio equipment

expedition by Rowe B. Metcalf and commanded by him will accompany the *Bowdoin*. The *Sachem* carries a particularly interesting short-wave equipment, about which more will be said later. It has been built and will be operated under the direction of RADIO BROADCAST Laboratory.

Professor Hobbs of the University of Michigan will shortly start for Labrador where he will set up a semi-permanent short-wave station as a part of his meteorological expedition to learn more about Northern weather. Operator Oscanyan, a New York amateur, will be in charge. Still another group with George Palmer Putnam started for Northern Greenland about July first, also depending on short waves for their contact.

One of the most reliable ways to step into the limelight in this day and age is to pack up a short-wave transmitter and make your way beyond the real estate developments. Then the *Times* will probably tell the world how you slept the night before, what you had for breakfast, and what birds twittered about you as you typed your dispatches.

The Radio Legislative Arena

IN NO department of radio has there been more active controversy than in the codification of its law. Interwoven with problems of wavelength assignments and administrative detail are such fundamental issues as freedom of speech, censorship, political influence, and the eternal struggle between the executive and legislative branches of our government. While Congress is actively considering radio legislation, we cannot predict what changes each day will bring. At this writing, we fear more no legislation at all, than the harmful effects of any particular bill or method of control proposed by the many influences seeking to shape the government's future policy.

State and local governments have been generally inactive in complicating the situation, but there have been two instances which merit attention. Bay City, Michigan, has adopted a municipal ordinance regulating radio reception and the legislature of the state of Washington is considering an Act which has the support of radio enthusiasts of that state.

Radio is regarded, in a legal sense, as an interstate matter and its regulation therefore falls within the jurisdiction of the national government. This is as it should be. While we may view with some impatience the slow formation of radio's legal structure, we must realize that the cautious approach of our legislators to the problem is engendered as much by the difficulty of writing radio legislation as by political considerations. Local legislation, however, imposing regulations upon broadcast listeners, is undesirable and burdensome. Radio's problems are national in scope and triple regulation by municipalities, states, and nation are bound to work hardship upon millions of owners of receiving sets.

Bay City has attempted to make radiating receivers illegal. The ordinance which it has adopted establishes a license fee of $2.00 for every radio receiver installed in the city. Sets must not be operated so as to radiate or cause disturbance with neighboring receivers. Violations are subject to fine up to $100 or three months imprisonment or both.

In a small community, where such a regulation might possibly be enforceable, protection against radiating receivers might be worth $2.00. But in cities, where radiation problems are most acute, no staff of radiation prohibition enforcement agents can hope to smoke out every invisible squeal, with a radiating speak-easy in every other home. Improvements in receiving sets and education of the listener offer a much more productive prospect than easily evaded and irksome local legislation.

Two factors must be considered with regard to radiation: first, the receiver itself and second, the skill and temperament of its users. No matter how good the intentions of manufacturers, a malicious or careless user can make almost any kind of receiver radiate. Merely legislating them out of business will not eliminate them. Engineers and manufacturers will ultimately solve the problem by developing non-radiating receivers so superior to radiating sets in point of sensitiveness, selectivity, volume, and economy that the incentive to cause howls and squeals will disappear.

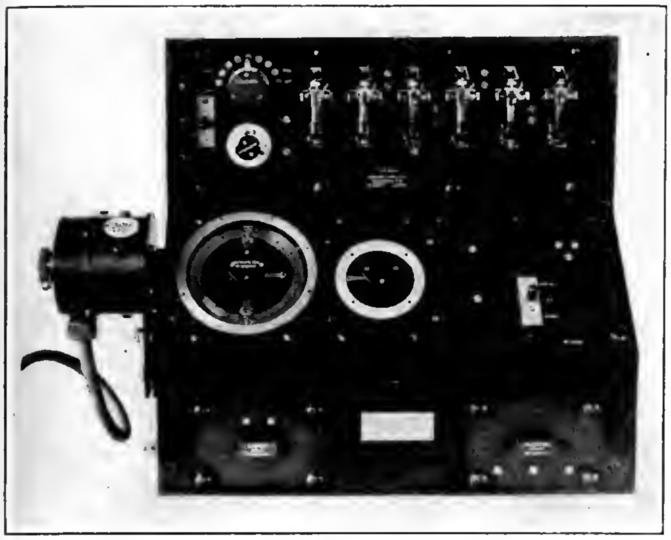
Correcting an Unfortunate Misstatement

ON PAGE 118 of RADIO BROADCAST for June, 1926, in an editorial captioned "Important Radio Patents at Present in Litigation" there appeared the following statement:

> There are at present being tried in the courts, several of the important radio patents, the decisions on which may very materially affect the radio business. The Armstrong idea of regeneration, insofar as it relates to oscillating tubes, is being contested by the government in a suit in the state of Delaware. Armstrong's priority over other inventors apparently depends altogether upon a sketch of a supposedly regenerative circuit, which was accompanied by practically no explanatory disclosure. Should this sketch be proved by the government's experts to be no true disclosure of the regenerative principle, there is a possibility that the Westinghouse Company may lose one of its most valuable radio patents.

The advance sheets of this article which reached 900 newspapers also contained the sentence, in reference to this sketch: "It was, to be sure, certified by a notary, but there has apparently been some question raised as to the genuineness of the notary's signature."

The editorial, from which the above is taken, formed the first paragraph of a report on patent suits now being litigated. Succeeding paragraphs had reference to other patents than those issued to Mr.



ENGLISH DIRECTION-FINDING EQUIPMENT

This photograph shows the combination direction-finder and the Sperry gyro-compass, manufactured by Marconi's Wireless Telegraph Company, London. The metal box fitted to the left side of the direction-finder is coupled to the ship's main gyro-compass. The variations of the gyro-compass are communicated to the metal ring of the dial of the goniometer, so that the true bearing of the ship can be directly obtained by reading from the outer ring without any correcting calculations. The bearing relative to the ship's head is read in the usual way from the inner ring of the dial. The radio receiver shown here, is of course connected to the special loop antenna on the bridge

Armstrong. Since the publication of the editorial referred to, it has been brought to our attention that the statement "Armstrong's priority over other inventors apparently depends altogether upon a sketch of a supposedly regenerative circuit, which was accompanied by practically no explanatory disclosure," and "it was, to be sure, certified by a notary, but there has apparently been some question raised as to the genuineness of the notary's signature," are entirely unjustified by the facts.

The sketch in question, which was certified by a notary, has been upheld as genuine by at least six different tribunals. Judge Julius Mayer said, from his bench in Federal Court, on one occasion:

> The signature which appears in the County Clerk's record, of course, is a different signature than that which appears on Plaintiff's Exhibit No. 37; and in such circumstances, I do not see that the defendants would be blamed, from any moral or sentimental standpoint, from taking any advantage that there may have been in that circumstance.
>
> As a matter of common experience, I have, of course, in my life, seen signatures of the same man that varied, for some reason or other, best known to himself. Men have peculiarities in such respects.
>
> I am perfectly satisfied on the testimony in this case that the signature to Exhibit 37 is the signature of the same man who was the notary, whose certificate was filed in the office of the County Clerk. (Exhibit No. 37 is the sketch with the notary's signature.)

In point of fact, there can be no doubt whatever that the signature, to which reference was made in the editorial in our June issue, is genuine. Obviously, the way in which the editorial, and the advance sheets quoted above, mentioned the sketch disclosing the regenerative circuit, cast suspicion on the character of Major Edwin H. Armstrong. RADIO BROADCAST has always had the highest respect for that famous radio worker and we are glad to state that there is no justification whatever for the suggestion in that editorial, real or implied, that he had been a party to dishonest or at the least, unfortunate practises, in the earliest recording of his regenerative circuit. The paper in question bears the date of January 31, 1913.

RADIO BROADCAST regrets very deeply that, in its effort to report the important radio news of the moment, any damage should have been done to the reputation of a radio investigator of the high standing and unquestioned character of Major Armstrong. We are glad to give this item equal prominence with the original editorial in our June number.

Washington Proposes to Make Interference Illegal

RADIO enthusiasts of the state of Washington are reported to be actively supporting a bill before the State Legislature, which is intended to eliminate interference by "electro-radiant" systems. Such systems are defined as any source of radiant electrical energy which interferes with radio reception.

The state's Bureau of Weights and Measures is to be charged with the enforcement of the measure. It is to be authorized to license radiant systems upon payment of a fee of $2.00 if the system does not interfere with radio reception. Owners of vacuum tube receiving sets are to pay an annual fee of $1.00. In addition, an appropriation of $25,000 is proposed to meet the cost of enforcing the Act.

Complaints of interference filed by broadcast listeners, when accompanied with a $10.00 fee, are to be investigated by the Bureau. If no interference is found, the fee may be returned to the complainant upon the discretion of the Bureau. If the source is found to be one which the Bureau has licensed, the fee is also returned and corrective measures are to be recommended to the owner of the interference source. If it is not a legalized noise, the owner of the system is called to pay the $10.00 and to eliminate the noise forthwith.

From the standpoint of the broadcast listener, the Act leaves nothing to be desired, unless he should happen to be a stockholder in a light and power company or is attempting to cure his rheumatism with an ultra-violet ray machine. Undoubtedly there are minor cases of noise interference which may be eliminated by corrective devices and improved insulation. But what will the harassed public service corporations, providing electric light, power, and traction at rates fixed by law, do if the Act is adopted by the legislature?

At the behest of any one owning a nine-dollar receiver, who pays an annual fee of $1.00, they may be compelled to spend

RADIO RECEIVERS IN QUANTITY

Completed receivers coming down the factory conveyor left in a New York radio factory. Large radio factories turn out their sets on the same efficient methods as does a certain large motor car maker of Detroit sums running into thousands of dollars to eliminate a single source of interfering noise. Until the radio listener is prepared to pay for his demands for a silent ether, he may rest assured that interference from power sources will not be universally eliminated. The telephone companies have wrestled with the problem of induction from power systems for many years and only by diplomatic coöperation have they been able to make progress. Had they attempted coercive legislation instead, the chances are that telephone lines would still hum with sixty-cycle "music."

Are 500 Kilowatt Broadcasters Coming?

ACCORDING to Harry Sadenwater, the engineer in charge of WGY, the next step in broadcasting may be the erection of a 500-kilowatt broadcasting station. He points out that each step in power increase—from half a kilowatt to five, from five to fifty—has invariably caused a wave of turmoil from listeners, which has been quickly silenced when the improved service resulting has been appreciated. Ten-folding the power, he states, only three-folds the service area and triples signal strength at any point.

The easiest way to overcome disturbing noises, whether from power lines or radiating receivers, is to provide increased signal strength. The effect of noise is diminished by a comparatively stronger signal. Radiation is lessened because the user of a regenerative receiver has nothing to gain when receiving strong signals by forcing his set to oscillate violently.

There are two important limitations, however, to continued increases in power. Within a radius of fifty to seventy-five miles, a 500-kilowatt station would more or less blanket reception. It would be difficult to locate such a station without excluding the reception of other stations to large numbers of listeners. WJZ's fifty kilowatts at Bound Brook has not been an altogether happy choice for a large and populous section of New Jersey, yet that station could not be located further from New York and still serve the metropolitan area satisfactorily. The other limitation lies in the high cost of maintaining a 500-kw. station.

In England the problem of providing a uniformly good signal in every part of the country has been attacked by a different method. In areas where the original British network of B. B. C. stations were not furnishing good signal strength, they have erected 100- and 500-watt relay stations and supplied them with programs by wire line connections. The British problem is greatly simplified by the fact that they do not seek to serve as large an area as American stations. The area of Great Britain is but twice that of Pennsylvania.

American listeners would be better served by a combination of the two systems than by the use of extraordinary power at widely scattered points. For instance, a chain of three 50-kilowatt stations, supplemented in congested areas by a series of 5-kilowatt stations would meet with greater public approval, without undue financial hardship upon the broadcasters, than would a single 500-kw. transmitter.

THE MARCONI SOUTH AFRICAN BEAM STATION

This is the transmitter house, located at Kliphevaal, near Capetown. The 800-foot tower on the left was originally built for a high-power station on which work has now been suspended. This station is one of the first of the group being perfected for the British Imperial chain, designed to link all the Dominions and Possessions with London. Other stations now nearing completion are at Bodmin in Cornwall, Bridgewater in Somerset, and in Canada. Much smaller power is required by the beam system than by the present method of longer wave, high-power work, the British Marconi Company reports

HARRY SADENWATER

New York

engineer in charge of stations WGY, KGO, and KOA

"The expression 'super-power,' when applied to a radio broadcasting transmitter operating on 50 kilowatts, is a misnomer The term is misleading and inaccurate, for actually 50 kilowatts of power is often used in lighting a sign, and when one considers the large amount of service that a broadcasting station is called upon to deliver to a large number of listeners, it seems ridiculous to call it 'super-power.' Discussion of 'super-power' leads many radio listeners to expect impossible results from 50-kilowatt transmission. Some feared to turn up their tubes lest the expected influx of power would destroy them. In reality, it was found that a tenfold increase in power (from 5 to 50 kilowatts), developed approximately three times the signal strength. The next practical step forward is to increase again the power of the radio broadcasting transmitters by a factor of ten. Such a step, to give any gain in volume to the broadcast listener, would mean an increase to 500 kilowatts in the case of WGY."

Who Will Market Radio?

THE music store, the electric store, the radio shop, the automotive supply store, the hardware emporium and the department store (perhaps we have omitted a few) have engaged, with more or less enthusiasm, in the retailing of radio equipment. As a consequence, the radio industry scatters its selling efforts through so many retail outlets that over-production and over-stocking is bound to result. One manufacturer who recently brought out a new line, stated that 30,000 of his sets were sold within six weeks, in spite of the summer season. Yet that number of sets is not sufficient to supply one sample of each type to each of his dealers. Under the cicurmstances, how can a manufacturer adjust his production schedules to the pulse of public demand?

The sooner the radio industry narrows down its channels of retail distribution to a reasonable number, the sooner it will be able to control production to demand. Everybody will be more prosperous—the dealer, with fewer competitors and larger volume; the manufacturer, with accurate knowledge upon which to base production; the public, with fewer, larger, and better equipped radio stores.

In the aggregate, it makes but little difference which of these channels is selected. Each can justly assert special qualifications. The music store claims to be the natural channel for the distribution of radio products because it knows how to sell sets as musical instruments, how to serve women, and how to handle time payments; the electric store because of technical knowledge in selling, servicing and repair; the automotive supply store, because of accessibility and experience with storage batteries; the hardware, because of influence in the rural community, and so on. We are loath to weigh the claims of the various groups, but from the standpoint of the radio public, one good prosperous radio department, with a comprehensive up-to-date stock is worth half a dozen neglected radio counters starving from needless competition.

The Month In Radio

A NEW 500-watt short-wave transmitter for transoceanic service has recently been installed at Chapultepec Park, Mexico City, according to an announcement from the Department of Commerce. The extensive wireless towers are being pulled down to make way for the small 45-foot antenna used by the modern transmitter. A similar outfit is being developed at the Chapultepec Radio Laboratories for installation at Campeche.

LITIGATION between the De Forest and Armstrong interests has been placed before the Supreme Court, as a result of the appeal of the De Forest Radio Telephone Company from the decision of the Federal Court in New York City, which restrained the De Forest Company from manufacturing a "regenerative receiver," known as the "D-17."

IF THE Naval Radio Service finds the demand for radio compass bearings continuing at the present rate of increase, one of the busy compasses is bound to develop a hot box sooner or later. The United States Navy reports that its compass stations furnished 126,607 bearings during the last fiscal year, without charge to mariners. Other countries charge between $1.25 to $1.50 for each bearing, so that, if a charge were made for each bearing at the lower figure, the Navy would have earned $158,257 for its service. During a recent month, a total of 19,952 bearings were given, showing a substantial rate of increase. Of this number, Cape Hatteras handled 1337, a record for any compass station for that period.

BY ALTERING its articles of association so that not more than 25 per cent. of its stock shall be held by foreigners together with other protective features, Marconi's Wireless Telegraph Company of England has recently secured a license from the British Postmaster-General to establish services with certain Continental and other foreign countries outside of Europe.

PROF. HUBERT TURNER

New Haven

Radio specialist, Dunham Electrical Laboratory at Yale. To the New York *Times:*

"The outlook for the elimination of static is not promising. Super-power, which is now being used at several of the larger broadcasting stations, will overcome static effects, however. The problem in the elimination is that static and signal waves both set up oscillations in the receiving circuits, and by attempting to eliminate the static, the desired signal is also decreased in amplitude. By the use of super-power in broadcasting, the person with a radio set can decrease the pick-up efficiency of his receiver without seriously interfering with the reception of the desired signals. The important thing is to make a signal strong as compared with the static, which is still there, of course, although its effect will be decreased. . . . A set which is not extra sensitive, and which gets local and near-by stations satisfactorily, is the best set to have. The less sensitive a set is, the less static is picked up."

Interesting Things Said Interestingly

H. B. KROGER, 2 ALL (New York; in a letter to the New York *Times*): Those in charge of radio installations on the *Norge* did not show good judgment when they chose the long waves for the transmissions from that ship. Several wavelengths were chosen in the vicinity of 333kc. (900 meters). When anything was received from the *Norge*, it was in such small fragments as to be almost meaningless. As the region north of the Arctic Circle is in continued daylight, and it is a well-known fact that transmission on the long waves is greatly affected by daylight, it was a great surprise to me to hear that the twenty- and forty-meter bands were not chosen. Luckily nothing happened to the *Norge* that would have made it imperative to establish good contact with another station. If, however, anything had happened, I believe that one more dirigible would have gone to its fate. Let us hope, for the safety of future expeditions, that that was the last omission of a short-wave transmitter in the equipment of such an undertaking."

How Was Reception Last Night?

A Description of the Pioneer Work and Methods of Dr. G. W. Pickard in Measuring Radio Signal Intensity—Circuits and Details Completely Shown Opening Up New Fields for the Serious Experimenter

By ALBERT F. MURRAY

Engineering Department, Wireless Specialty Apparatus Company

ON A chilly corner of Boylston Street, in Boston, two old friends meet; one a radio dealer, the other a radio engineer. After greeting each other the dealer asks; "Well, Al, how was reception last night?"

"Very poor, I think, Harry, but look in tonight's *Transcript;* they usually give an accurate report. Why the frown?"

"Was I frowning? It must have been because this long run of poor radio weather is not only spoiling business but has been getting on my nerves. This morning another customer who bought an expensive set from me at Christmas time said that WJZ was the only station, except the locals, that he could pick up, and that he wanted to return the set."

"Yes, I know how it is," replied the engineer, "friends ask me what is wrong with their sets or what is wrong with the ether. There is nothing wrong with the former and what is wrong with the latter cannot be fixed."

"Why don't you engineers do some research on this erratic ether of ours? Do you know I would give five-hundred dollars right now, for five consecutive good radio nights!"

The engineer smiles, but realizing the seriousness of the situation suggests to his companion:

"Another thing that money can not buy. Money can erect high-power transmitters, but even these stations cannot force their signals through 'dead spots' in the ether. Yet at other times, when ethereal conditions are right, a mediocre half-kilowatt broadcaster will be heard half-way across the country.

"But don't think that this most interesting and truly universal question of radio transmission is not being looked into by scientists. There are, for instance, twenty-eight college, corporation, and private laboratories coöperating with the Bureau of Standards, in gathering data on fading, etc. Do you remember the fading records taken during the eclipse of 1925? Well, this whole project was under the guidance of Mr. G. W. Pickard."

"Oh, yes, I know Mr. Pickard. He is consulting engineer, Wireless Specialty Apparatus Company, and among other things the inventor of the crystal detector and the loop direction finder. I once heard him give a paper before the I. R. E."

"As I was saying," continued the engineer, "Mr. Pickard is an authority in the radio world on variations in radio transmission, having published charts showing such variations as early, I find, as 1905. Each year during the last twenty-one, he has explored further and further the mysteries of what happens to radio waves as they travel from transmitter to receiver. Although it is not generally known, he is now engaged in measuring, during a two-hour period each night, the field strength of a certain broadcast station in Chicago. In fact, he has shown me continuous signal strength and static records which he makes on long rolls of paper."

A New Field For The Ambitious Experimenter

"HOW does the broadcast carrier wave travel? No one knows. That is why we are recording and collecting data little by little, in a methodical effort to piece together the answer to the gigantic—yet probably simple—puzzle, of what happens in the intervening link between receiver and transmitter. The more radio listeners who turn observers, the faster the data will accumulate and the quicker we will all know the answer to the puzzle. Once knowing the answer, it is logical to believe that many of the limitations and vagrancies of transmission will be overcome to the great gain of all of us who are users of radio. To those broadcast listeners, who, having become fascinated by the mysteries of radio, have developed into serious radio experimenters, and are looking for new fields of endeavor, this interesting subject of research is heartily recommended. No technical preparation is necessary. If properly carried on, the results are more satisfying and worth while than, say, learning the code or operating an amateur transmitter."

DOCTOR PICKARD

Whose experiments to determine what happens in the ether between transmitter and receiver, are related in this article by Mr. Murray, one of his associates

"Can one see from these records how strong signals from Chicago are?" asked the dealer.

"Yes, and the strength of static, too."

"Did you ask him how reception was the last week?"

"He said, except for one night, reception had been poor," reported the engineer.

"Ha, an idea!" the dealer wore a wide grin. "Could I get these records to show my customers?"

"I don't know. Your customers, except those scientifically inclined, would not care to bother with the inspection of a very jagged line running the length of a six-foot strip of paper to find out whether reception last night was good or poor. However, Mr. Pickard has worked out a 'Reception Factor,' a number, which, when obtained from each night's record, gives at once an idea, not only of whether the night was good or poor for radio, but how good or how poor."

"Say," the dealer becomes enthusiastic, "such scientific measurements of reception are just what we need. If they were only published!"

"I asked Mr. Pickard why he did not write, in that inimitable style of his, about these measurements and the interesting data which he has been collecting for weeks."

"And what was his reply?"

"That he, having to be at the radio recorder six nights a week, did not have time just now. I believe, however, he would be glad to give the facts for publication. Have you heard the term 'De-bunking Radio?' Well, Mr. Pickard, in common with other scientific radio men, believes in aiding in the 'de-bunking' process, so naturally he prefers to see the radio public furnished with accurate scientific data on reception conditions, since, at present, there is so much 'bunk' about the relation between radio and the weather being circulated by partially informed experimenters, so-called radio weather forecasters, and the like."

"Yes, even I am able to tell by nightly checks that newspaper radio forecasts are wrong as much as fifty per cent. of the time," said the dealer.

"Mr. Pickard is also anxious to interest as many radio experimenters as possible in this interesting game of recording, so that by a broad systematic research, such as you asked about a few minutes ago, it will be possible to find out more about the elusive ether—if indeed there is such a thing," said the engineer. "To tell the truth, my own interest has grown to such an extent that, if I can arrange it, I am going to attach a signal recorder to my receiver and follow some definite line of research. Doctor Pickard has kindly asked me to come to see his recording apparatus and I am going Tuesday evening."

"Well, Al, don't forget to ask him to make available to all of us, the reception data which he is taking."

And Tuesday night finds a visitor at Mr. Pickard's door. A few moments later, the visitor is being shown to the library-laboratory by the genial host himself.

What the visitor saw and what he learned from Mr. Pickard, concerning the recording of radio signals, the apparatus, and methods used is told below.

THE GRAPHIC RECORDING OF RADIO SIGNALS

THE most commonly used recorder of radio reception to-day is the human ear. Unfortunately, as ordinarily used, the accuracy of this recorder is so low that signals can vary

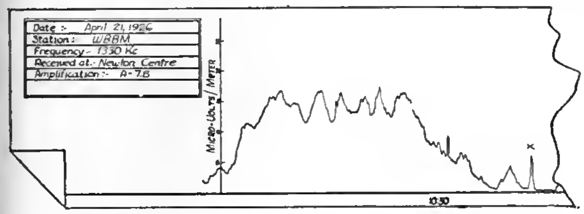


FIG. I

A typical reception record as made with a Shaw Recorder. Note the peculiar carrier-wave variations, many of which would not be perceptible to the human ear

100 per cent. in intensity before a change is noticed. This means that for accurate results, upon which scientific conclusions can be based, the response as noted by the unaided ear can not be used, especially if the greatly varying intensity of speech and music is used to judge reception conditions. Therefore, since listening with phones or loud speaker to broadcast stations does not give results that are dependable, for investigations of radio reception, it is necessary that the r. f. output of the radio receiver be rectified and passed through a galvanometer, the reading of which is recorded either intermittently, by noting the scale reading, or continuously on a moving strip as is done in the Shaw Recorder.

As is well-known, the carrier wave received from the average near-by broadcast station in daytime, remains fairly steady. Fading and night-time effects, of course, make it vary greatly, and these are the variations in which we are interested in recording and studying. When looking at the peculiar variations in a typical reception record, reproduced in Fig. 1, it should be understood that it is not the audible variations, due to speech frequency modulation, which are recorded, but the moment to moment change in the intensity of the carrier wave. This "carrier," as far as the broadcast transmitter is concerned, is radiated with constant amplitude, only to be twisted, deformed, suppressed, refracted, absorbed, by the medium in which it travels. How does it travel? No one knows. That is why we are recording and collecting data little by little, in a methodical effort to piece together the answer to the gigantic—yet probably simple—puzzle of what happens in the intervening link between radio transmitter and receiver. The more radio listeners who turn observers, the faster the data will accumulate and the quicker we will all know the answer to the puzzle. Once knowing the answer, it is logical to believe that many of the limitations and vagrancies of transmission will be overcome to the great gain of all of us who are users of radio. To those broadcast listeners who, having become fascinated by the mysteries of radio, have developed into serious radio experimenters, and are looking for new fields of endeavor, this interesting subject of research is heartily recommended. No technical preparation is necessary. If properly carried on, the results are more satisfying and worth while than, say, learning the code or operating an amateur transmitter.

For those who wish to collect data on radio reception, the necessary equipment is described below in sufficient detail to give the average experimenter an idea of the apparatus he should have if he wishes to make observations so as to be able to answer the question, "How was reception last night?"

This list of apparatus includes the antenna, the receiver, the rectifier, the recorder, the calibrator and—the observer, for he must become a part of the equipment, possessing to some degree the patience, reliability, and tirelessness of a machine. It is surprising, however, how quickly the observer falls into the way of automatic recording, that is, the necessary motions become reflex actions.

WHAT EQUIPMENT IS NEEDED

THE Antenna (1.) should be of the open type in order to avoid directional effects. It should be substantial and permanent with the lead-in wires rigidly fixed in place so that there is no change from day to day in antenna characteristics. It is desirable to know the effective height of the antenna at the working frequencies. A simple way of measuring this will be described later.

2. The Receiver should cover the desired frequency range with tuning controls that can be accurately set and logged. Radio amplification is necessary (unless powerful radiations from near-by transmitters are to be studied), and the amplifier must be of a type such that considerable amplification can be obtained with stable operation. It is very important that the amplifier be equipped with an amplification control which can be calibrated. For the sake of constancy, both A and B power should be supplied from storage batteries. Since the degree of amplification is usually dependent upon the filament and plate voltages, both of these, especially the former, should be indicated by voltmeters easily visible to the observer. Receivers of the so-called regenerative type are barred. The neutrodyne receiver has been used, with a separate heterodyning oscillator, but the super-heterodyne is recommended, since it possesses the required sensitivity and, if the intermediate amplifier is stable, the required reliability.

While the audio amplifier portion of the receiver is not necessary when a recorder is used, it is retained for the purpose of operating a loud speaker, or phones, used in monitoring.

Special attention is directed to the amplification control on the receiver. The signal intensity from the station being recorded may vary widely, so that in order to keep the needle of the recording galvanometer on the scale it is necessary to change the output from the receiver from time to time, by changing the sensitivity a definite and known amount. After trying several methods of control, it appears best to calibrate a variable resistance, shunted across the input to the radio, or intermediate-frequency amplifier; or to vary the rheostat controlling the filament brilliancy of *one* of the amplifier tubes. The variable coupling between the antenna and the tuned secondary circuit of the receiver may be used, after calibration, to vary the output to the recorder. The method of calibrating will be explained later.

3. The Rectifier. Since the recorder galvanometer operates on pulsating d. c. it is necessary to rectify the received a. c. energy

"RECEPTION FACTOR" TABLE

Mr. Pickard has worked out a "Reception Factor," a number which, when obtained from each night's record, tells at a glance just how good or how bad reception was on any particular night. The table below was compiled by listening to WBBM, Chicago, between 9-11 P. M. E. S. T. nightly, except on silent nights.

DATE	RECEPTION FACTOR	STATIC
May 4, 1926	79	0
5	—	–
6	14	0
7	65	0
8	218	1
9	173	2
10	—	–
11	225	3
12	258	3
13	165	3
14	8	1
15	22	3
16	148	3
17	—	–
18	210	3
19	245	3
20	266	1
21	219	2
22	60	2
23	46	2
24	—	–
25	188	2
26	258	1
27	186	1
28	290	0
29	241	0
30	334	0
31	—	–
June 1	61	1
2	—	–
3	—	0
4	107	2
5	77	1
6	94	1

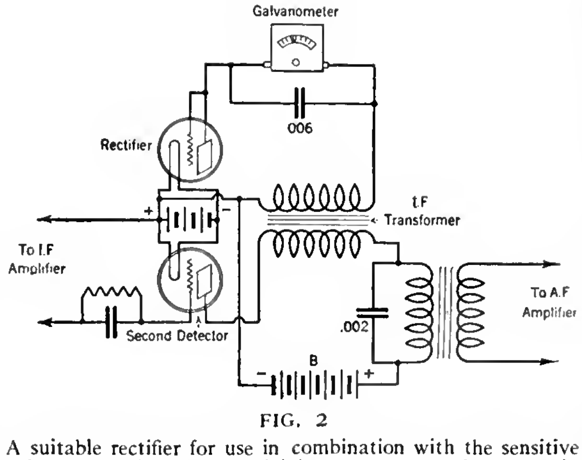


FIG. 2

A suitable rectifier for use in combination with the sensitive galvanometer is formed by joining together the plate and grid terminals of a 199 tube, and connecting it in the circuit as shown in this diagram (of intermediate frequency, say 40 kc.), before it will work the sensitive galvanometer. A sensitive measuring instrument must be used, otherwise the rectifier is likely to be overloaded, under which condition its output is no longer proportional to the square of the input voltage. The importance of maintaining the square law relationship is mentioned below. A crystal detector may be used for this purpose, but a more satisfactory and dependable rectifier is formed by joining together the plate and grid terminals of

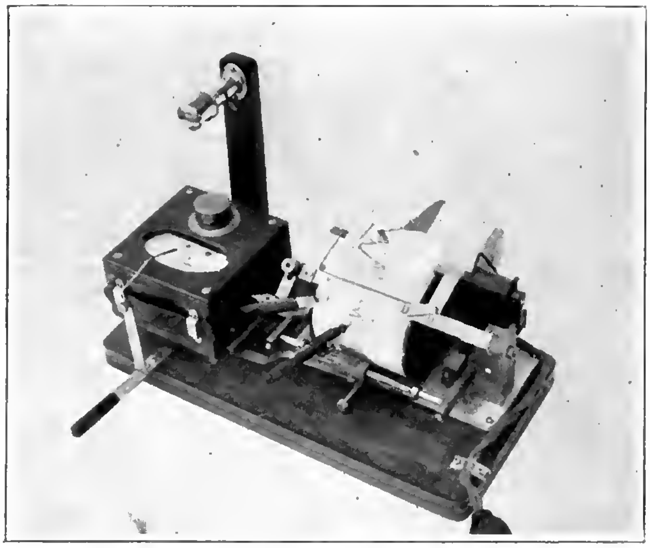


FIG. 3
The Shaw Recorder, a manually operated graphic signal recorder. The instrument illustrated is a product of the General Radio Company

a 199 type tube and connecting it in the circuit in series with the galvanometer and intermediate transformer secondary, as shown in Fig. 2. The connections in this diagram show the insertion of the primary of an extra intermediate-frequency transformer in the plate circuit of the second detector of a super-heterodyne, in a way that does not disturb the audio amplifier. The auxiliary rectifier tube handles only the inaudible 40-kc. intermediate frequency voltage which is fed to it through the radio-frequency transformer, hence its rectified output does not vary at the voice or modulating frequency, but is proportional to the square of the amplitude of the carrier wave. Since the filament voltage of this tube must be kept constant, it is well to have the filament controlled from the same rheostat that controls the other tubes in the receiver.

4. The Recorder. The output of the rectifier operates a sensitive micro-ammeter, the readings of which can be noted and plotted, but since the intervals between reading should be small if a complete record is desired, this method while not requiring extra equipment, is very laborious.

USING THE "FADING RECORDER"

MR. H. S. SHAW, of Boston, who has been engaged with Mr. Pickard in radio reception measurements for the last several years, has designed a manually operated graphic signal recorder, known as the Shaw Recorder. This instrument, shown in Fig. 3, consists of a galvanometer (14 micro-amperes full scale), mounted so that a movable index, attached to the handle protruding at the left of the picture, can be made accurately to follow the movements of the galvanometer needle. Attached to the handle is a sliding carrier holding a fountain pen which, moving over the paper strip, leaves an ink line trace, varying in position with the galvanometer reading, if the observer, watching the meter, keeps the index pointer aligned with the galvanometer pointer. This alignment is made easy by the automobile dash lamp, which is located above the instrument in a way that the shadow of the index pointer falls across the scale and therefore upon the meter needle. The paper tape, being attached to a slowly rotating brass drum, by means of tiny spikes, is unwound at a constant speed, since the small electric driving motor is a synchronous a. c. one similar to those used in electric clocks made by the Warren Clock Company. A second fountain pen is set to trace the zero line on the reception chart, as shown on the sample record in Fig. 1. The speed of the paper past the recording pen is approximately five-eights of an inch per minute. With a rectifier tube connected as described above, a small steady current flows through the galvanometer when there is no incoming signal. This steady deflection is reduced to zero by some operators by turning the zero-adjusting screw on the meter; Mr. Pickard, however, pointed out to the writer that he allowed the pointer to come to rest at about one-half of a division above zero, when no signal was being received, so that this slight zero reading would indicate to him that the receiver filament voltage was normal.

The Shaw Recorder can be purchased from the General Radio Company, Cambridge, Massachusetts, under the name of "Type 289 Fading Recorder." For field work, where a. c. is not available, recorders equipped with spring motors can be supplied.

5. The Calibrator. In order to maintain the sensitivity of the receiver constant from night to night, or from hour to hour, some type of miniature transmitter, the output of which can be adjusted to and held at a known value, must be provided to operate over the desired frequency range. An easy way to fulfill this requirement is to construct an oscillator, using a UX-120 tube, connected in a standard oscillating circuit which utilizes the tuned grid circuit. The variable tuning condenser is in series with a Weston thermo-galvanometer (115 ma. full scale), so that the oscillating current can be adjusted to the required value by means of the filament rheostat. This oscillator, if unshielded, will have to be placed 50 to 100 feet from the receiver and adjusted to have a known output at the desired frequency. The strength of the received signal is then noted by reading the deflection of the recorder galvanometer when the receiver is properly tuned and the amplification control at a definite setting. This test for receiver sensitivity is made when the distant radio transmitter is not in operation. Or, the testing is done at a frequency slightly different from that which would give a noticeable deflection due to the remote station. As soon as the amplification of the receiver is checked, or adjusted to the normal value, the local oscillator is stopped and we may begin to record reception from the selected station. Careful tuning is imperative. After a few minutes of recording we will probably find that the signal, gradually increasing in strength, will reach such an amplitude that in order to keep the galvanometer on the scale it will be necessary to drop the receiver amplification to the next lower position. Now, such positions should have been marked on the amplification control dial when the oscillator, known as the "calibrator," was running. One adjusts the oscillator output until, using maximum amplification, the galvanometer reads 100 divisions. Next, decrease the amplification until one quarter this reading is obtained, 25 divisions, and at this point mark the amplification control in a manner that indicates that the sensitivity of the receiver has been reduced one half of its former value. Lower ratios than two to one are often needed. They may be obtained by allowing the amplification control to remain in the last mentioned position and increasing the calibrator output so that a 100 division deflection is again noted. This reading may then be dropped to one quarter of its value, as before, and thus the amplification control dial is calibrated at another point, corresponding, this time, to one quarter maximum sensitivity. Remember that the deflection of the galvanometer is proportional to the square of the received voltage.

The use of the calibrator, as outlined above, is necessary if one night's results are to be compared with those of the preceding night, since it is necessary to check receiver sensitivity at least once each day. While, by its use it is possible to compare various records taken at different times by the same observation station, it is not possible to compare easily records obtained from other radio observatories in different parts of the country unless a uniform scale of signal strength measurement is used. As radio experimenters know, the signal, or field strength of a radio wave is expressed in micro-volts per meter.

RADIO RECORDS IN MICRO-VOLTS PER METER

IN ORDER that our records will indicate the signal strength at our receiving antenna in the universal unit of micro-volts per meter, it will be necessary to add three resistances to our calibrator set-up so that we can obtain from it very small voltages of known value. These are arranged as indicated in Fig. 4. The total oscillating current, read by the thermo-galvanometer-flows through the 1.0-ohm resistance marked "A." The voltage drop across this forces current through resistance "B," 29 ohms, and a slide-wire which has a resistance of 1.0 ohm.

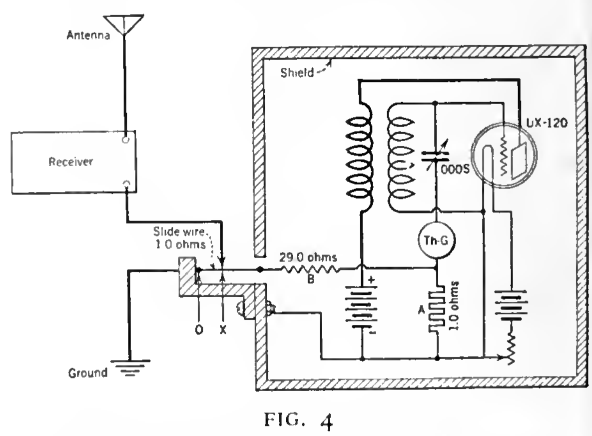


FIG. 4
Three resistances are arranged in the calibrator set-up so that very small voltages of known value may be obtained

A slider moving over the calibrated slide-wire, is so connected in the receiver ground lead that the voltage (in micro-volts), injected into the antenna by the calibrator, can be computed. For convenience the calibrator must now be near the receiver and this means it must be well shielded. Mr. Pickard found a copper wash-boiler made a satisfactory shield. His calibrator is shown in Figs. 5 and 6.

The writer knows from the difficulties experienced in measuring the effective height of the transmitting antenna of a naval station near Newport, Rhode Island, by the method of measuring the field strength, how important it is to have complete shielding when making field strength measurements with a sensitive receiver, and wishes to caution experimenters that the shielding must be good enough, so antenna enters into consideration, if we would know the field strength of a distant station in micro-volts per meter. This can be obtained by locating the unshielded calibrating oscillator at a point two or three wavelengths away from the receiving station. Enlarge the coil in the oscillating circuit to the proportions of a loop antenna if necessary, so that a fair signal is produced at the receiver with a known oscillating current (of the desired frequency) at the tiny transmitter. If the receiver has previously been calibrated, the intensity of the received signal in micro-volts can be ascertained. A value for the received current can be obtained if the antenna resistance is known. By using this value of current in the Bureau of Standard's formula for loop to open antenna transmission and by substituting the physicial di- described above. Imagine that the battery voltages are right and the receiver amplification has been checked, the fountain pens on the recorder filled (and our favorite pipe filled as well). The lights in the room are lowered so that in the semi-darkness the galvanometer pointer can be more easily followed by the light of the little lamp above it. It is two minutes to nine. The receiver is switched on and the recorder is started to get an indication of the background noise. An occasional click of light static is heard from the monitoring loud speaker. As the clock on the wall indicates 9 P. M. the carrier-wave comes on, then the announcer's voice, from the distant station under observation, reaches us faintly. The ink line on the paper strip pushes upward. The frequency of the carrier wave of the distant station is so constant

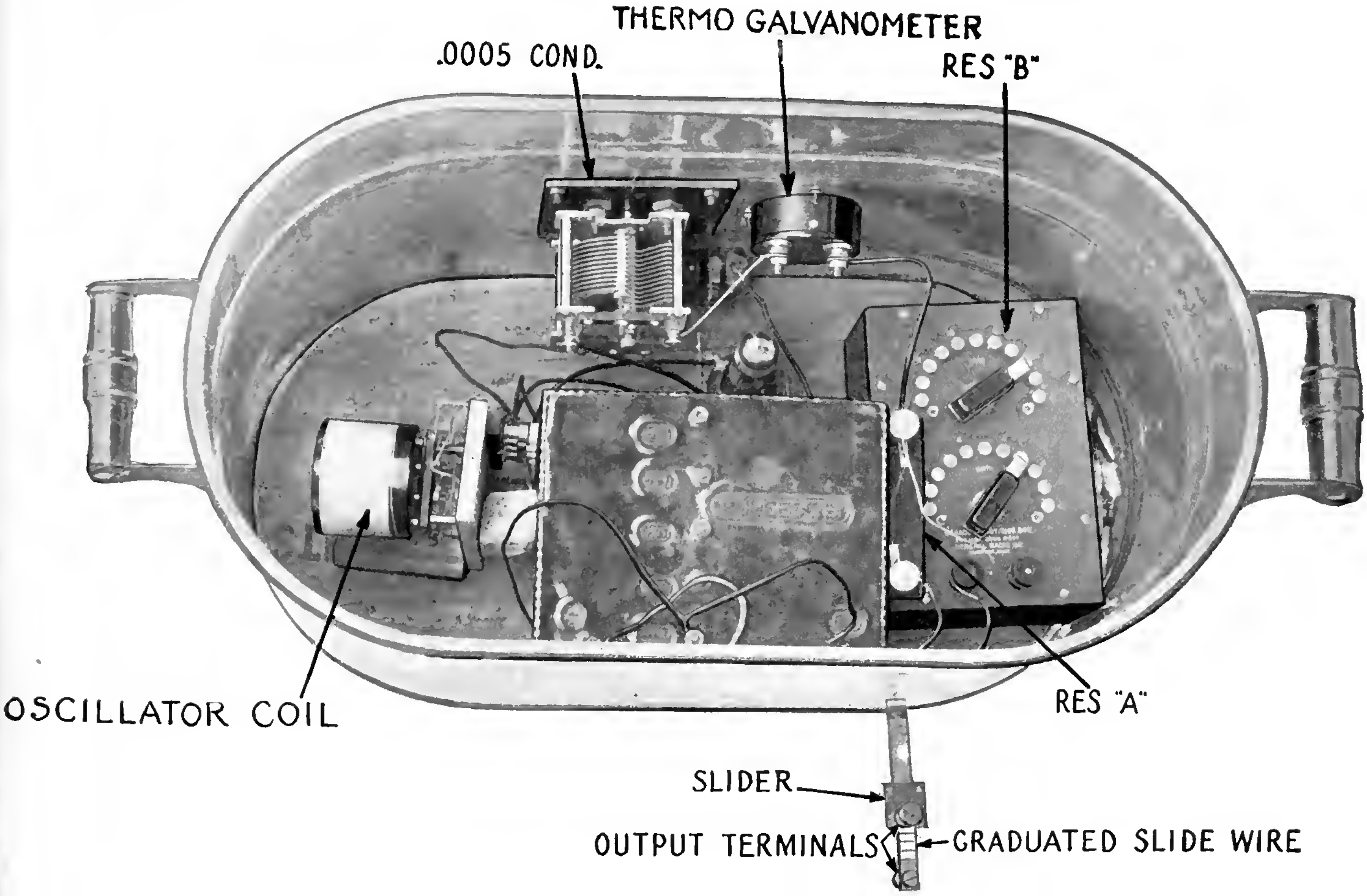


FIG. 5

For convenience the calibrator must be placed near the receiver, which means that it has to be well shielded. Doctor Pickard placed his calibrator in a copper wash-boiler, as shown in the illustration above

that there is no recorded galvanometer deflection, even with maximum amplification, when the calibrator is running but its output control (the slide wire) is set at zero. The easiest way to attain this, is to follow closely the lay-out of apparatus shown in the picture of the interior of the wash-boiler shield, Fig. 5. Mr. Pickard says that it is best to ground to the shield at one point *only* to prevent circulatory currents in the copper.

Because of the mathematical example, illustrating how to compute the recorded field strength in micro-volts per meter, and because it is of general interest to the reader, the page of Mr. Pickard's log dated February 22, 1926, is reproduced in column three of page 304. The diagram of the calibrator, which appears on the original page, is reproduced here as Fig. 4.

It will be noted that the effective height of the mensions of the loop, the effective height of the receiving antenna is computed.

In completing this description of the equipment of a "Radio Observatory," attention is called to the excellent report of Mr. T. Parkinson, Bureau of Standards, on *Coöperative Investigation of Radio Wave Phenomena*, R1130, containing information on apparatus and procedure of interest to those who are investigating radio reception.

THE PROCESS OF RECORDING

As is usually the case, a certain amount of rather tedious work must necessarily be done before we arrive at the place where we get everything going smoothly and can sit back and enjoy the results. That radio recording is fascinating, there can be no question.

Let us try recording with the apparatus that it is not necessary to retune the receiver from night to night. We are fortunate in having this kind of a station to observe. The line on the chart works higher and the music from the loud speaker is of fair volume. The occasional beat note from a neighbor's oscillating receiver is heard, but it does not affect the recorder appreciably, and since the signal is weak, the neighbor quickly gives up and moves away on a quest for easier game. It is interesting to see how much the received carrier-wave intensity has to change on the record before the ear tells you that the sound has begun to increase. Occasional clicks of man-made static are recorded, recognized and marked with an "X" by the observer, to distinguish them from real static, which is now making our record quite jagged. The signal slowly fades out. A red pencil in the hand of the observer notes on the record when the signal becomes inaudible and later when it rises again to audibility. The correct time is also marked on the moving paper at each half hour period. In the next few minutes the signal rises to a peak; the soprano's voice is ringing through the room, only to die away in a prolonged fade out. The observer, puffing at his pipe remarks, "It may turn out to be a fairly good radio night." Static increases, until the peaks cause full scale deflections of the galvanometer. Each of these are followed by the observer who almost automatically moves the signal recorder handle with an easy sweep of the wrist. As is customarily the case, the signal increases with the static and the night is beginning to have the earmarks of a "good" radio night. But to actually determine how reception has been it is necessary, when the record for the period has been completed, to calculate the "Reception Factor." This convenient factor, originated by Mr. Pickard, makes it possible to give broadcast listeners an accurate answer to "How Was Reception Last Night" since it is a combined measure of the length of time the distant station was audible and the loudness of the signal peaks.

FIG. 6

This is an exterior view of Doctor Pickard's calibrator mounted in a wash-boiler shield. The arrangement of the apparatus may be approximated by glancing at the interior view of this unit, as shown in Fig. 5 on page 303

EVALUATING THE RECEPTION FACTOR

TO OBTAIN the "Reception Factor" from a record, Mr. Pickard notes in every half-hour period (a) the percentage of the time the station was audible, to which he adds (b) ten times the average of the highest signal peaks in micro-volts per meter. The evening's Reception Factor is the average of the half hour periods. A plot of this Reception Factor for the past months is shown in Fig. 7. The intensity of static, as shown on this graph, is obtained by averaging observations on the height of the static peaks above the varying amplitude of the carrier-wave as shown by the records, combined with the aural impressions of the observer, who listens as he records. The curve showing the average radio reception has an interesting form. A few of the conclusions which may be drawn from it, relating to much discussed questions, such as the effect of weather on radio, will be discussed in a later issue of this magazine.

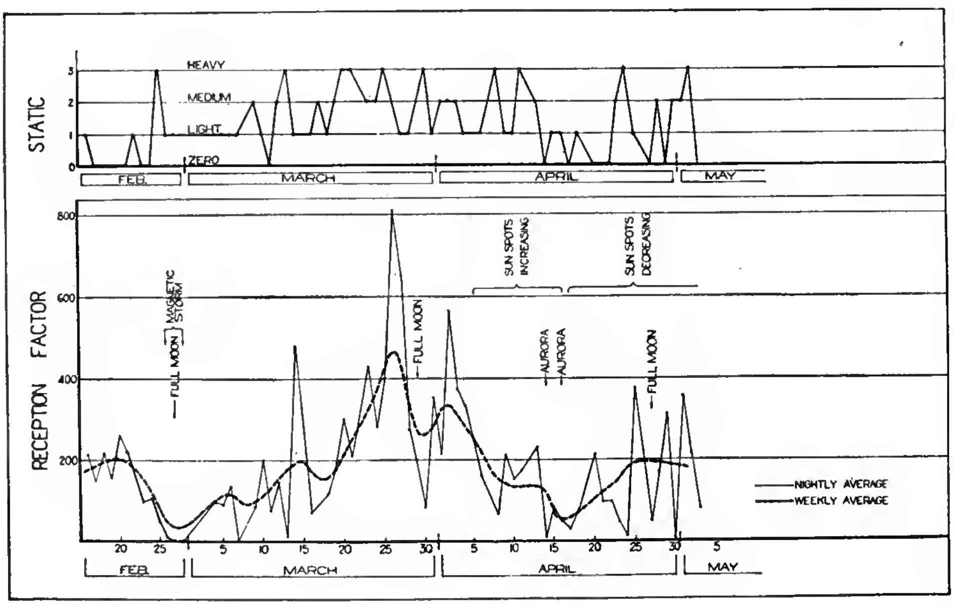


FIG. 7

A typical Reception Factor chart. The intensity of static may be told by merely glancing at this chart

FIELD INTENSITY MEASUREMENT

February 22, 1926

Calibration of record in micro-volts per meter.

With the oscillating circuit enclosed in a No. 8 copper washboiler, and the ground lead from the receiver at 0 on the slide wire, the shielded oscillator was turned until it gave zero signal in the receiver. The shielding was complete electrostatically, but there was a slight magnetic field outside the shield, which could be so directed that it did not couple with the receiver.

The antenna was a flat top, with an effective height of 8 meters. The Weston thermo-galvanometer had a 30-division scale, with full deflection on 89 milliamperes (special meter). With the receiver tuned to WBBM's frequency, 1330 kilocycles, and an amplification of 64X, the following readings were taken:

Thermo-galvanometer, 3.5 scale divisions, current 31 milliamperes (obtained from calibration curve taken at 60 cycles) 0—X=0.375 inch, slide wire resistance 0.455 ohm per inch. Galvanometer on Shaw Recorder, 100 scale divisions,

Voltage across A, 0.03 volt. Current in circuit A, B, 0, 1 milliampere. Voltage drop per inch of slide wire, 455 microvolts. Voltage across 0—X, 171 microvolts. Corresponding field strength for 8 meters effective height, 21 microvolts per meter.

Radio Broadcast Photograph

THE "LOCAL" RECEIVER

This front view gives an idea of the simplicity of the tuning; the two large dials on the condensers are the only controls

A High Quality "Local" Receiver

Another Version of the "Radio Broadcast Local Receiver"—Wise Shielding and Good Design Offer a Selective Set for Purely Local Programs With High Quality as the Primary Object

By KENDALL CLOUGH

THE receiver described and pictured in this article is the result of an attempt by the author to present a receiver designed primarily for local reception, and one which is so simple in assembly that the average man, possessing little or no knowledge of radio technicalities, will have no difficulty in putting it together and operating it. The "Local" Receiver is capable of real quality reproduction, is low in upkeep and initial cost, and dependable to the last degree. It is a version of the Radio Broadcast "Local" Receiver first described in the May issue. Its advantageous points can best be brought out by an examination of the circuit and material used.

From the rear view of the receiver, Fig. 1, we note that at the right-hand end is a shielded can containing a stage of tuned radio-frequency amplification preceding the detector tube which, together with its circuits, is contained in the next shield. At the left of these two stage shields is an audio amplifier consisting of two amplifying transformers, two tubes, and an output transformer. These parts are represented symbolically in the schematic diagram, Fig. 3, which will serve as a basis for an explanation of the points of the receiver.

While at first it may seem unimportant in a local receiver to employ such careful and effective shielding, yet this is one of the factors which contributes materially to the overall efficiency of the outfit. The shielding tends to stabilize the operation of the r. f. amplifier by eliminating practically all of the feed-back between the detector and r. f. amplifier circuits. In any radio receiver an antenna is used to collect the desired signal energy which, if the receiver is to function properly, must pass progressively through the various circuits, designed to provide adequate selectivity. If shielding is not employed, strong local signals will be picked up on the receiver coil systems and wiring with resultant poor control of selectivity. The two stage shields employed in this model of the Local Receiver eliminate this condition as effectively as can be done simply since their seams are all quite tightly closed. They further tend to prevent the pick-up of local noise such as that produced by X-ray machines, motors, and other forms of electrical equipment. While this pick-up is not completely done away with, the undesired energy is forced to come through from the antenna circuit, and a large portion is eliminated due to the selective effects of the tuning circuits—a condition that would not hold were it picked up on the coil systems themselves.

At the left of the diagram, Fig. 3, will be seen a coil serving to couple the antenna circuit to the input of the radio-frequency amplifying tube. This tube, its tuning condenser, and coil system, is contained in an aluminum stage shield $7\frac{1}{2}$ inches deep, 5 inches high, and $3\frac{3}{4}$ inches wide. The coil employed is of an interchangeable type, plugging into a six-contact socket. The grid inductance is composed of enameled copper wire wound upon a threaded, ribbed, moulded bakelite form. Thus, the winding, supported at but six points about its circumference, has spaced turns. The actual shape of the coil, together with the wire size, insulation, support, and general design, provides an inductance of extremely low high frequency resistance and, further, of extremely low distributed capacity.

The antenna coupling coil consists of a coil of silk-insulated copper wire with turns wound closely together and inserted inside of the grid winding. This primary is located in a very intense magnetic field and serves to give maximum inductive coupling with a minimum of capacitive coupling, since it is approximately one-quarter of an inch away from the grid winding at all points. A small feed-back winding is wound in a slot in the moulded form at the bottom end of the grid inductance. This coil is connected in the plate circuit of the radio-frequency amplifying tube and may be arranged to oppose oscillation in the r. f. amplifier. At times this is an extremely important factor, as will be seen later, and serves to stabilize the r. f. amplifier over the entire broadcast wavelength range.

The socket taking the coil-form carrying these three windings, is provided with the necessary contact springs making contact with buttons on the coil-form. It is mounted on studs so that it is located in the exact

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What the Radio Broadcast "Local" Receiver Is

Special Characteristics of the Receiver

High-quality reception from local stations, with very simple tuning adjustments. The set will operate satisfactorily on a short indoor or outside antenna.

Type of Circuit

One stage tuned radio frequency, a non-regenerative C-battery detector, and two stages of high-quality transformer coupled audio amplification.

Shielding

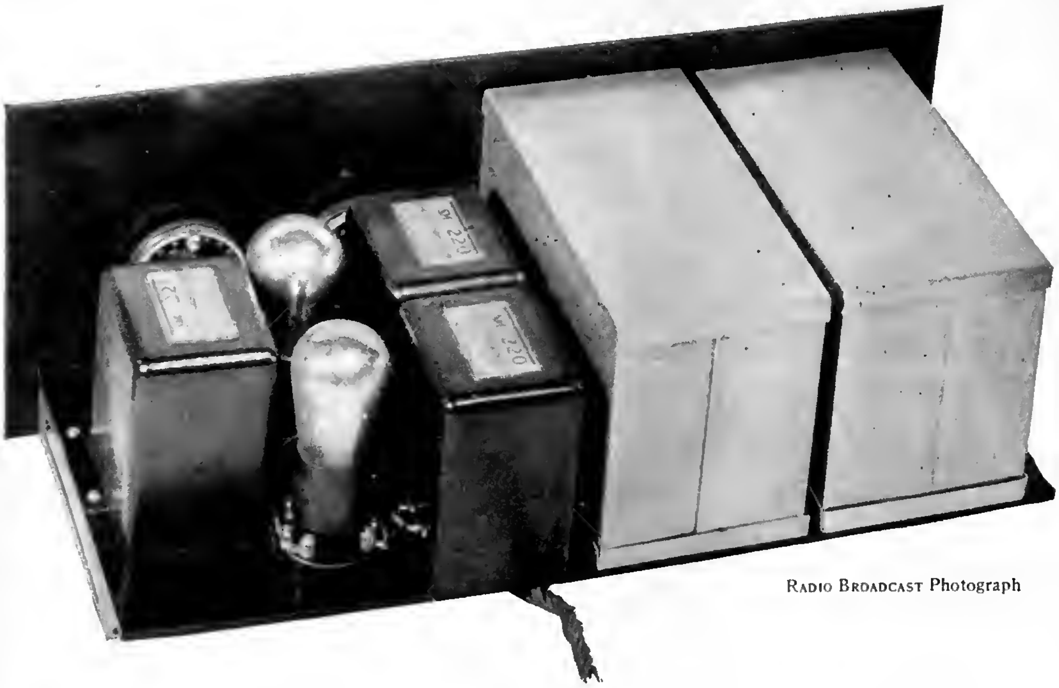
Both radio frequency and detector circuits are completely enclosed in cans which act as total shields to minimize greatly undesired pick-up and unwanted inter-stage coupling.

Coils

Standard coils having the usual primary and secondary may be used. Specifications for building one's own coils are given in the article.

Tubes

Radio frequency amplifier—a 199 or 201-A (preferably a 199).
Detector—201-A
First audio amplifier—201-A
Second audio amplifier—112 or 171



RADIO BROADCAST Photograph

FIG. 1
A rear view of the completed receiver. At the right are the two stage shields, with their covers on

center of the stage shield, from top to bottom. This serves to introduce a minimum of resistance by virtue of the shielding.

A stage of r. f. amplification has been used ahead of the detector in order that the receiver may be operated with a small antenna, either indoor or outdoor, and in order to provide the requisite degree of selectivity for satisfactory operation in congested broadcasting centers such as New York, Chicago, and Los Angeles.

The detector circuit is made up of a coil system exactly similar to that employed in the r. f. amplifier, with a 0.00035-mfd. tuning condenser.

DON'T OVERLOAD THE DETECTOR

SINCE this receiver will be operated on comparatively strong signals at all times, it is important that the detector tube be not overloaded for, if this should occur, quality will be ruined before the signal ever reaches the audio amplifier. Since the handling capacity of the detector tube operating with a grid condenser and leak is very definitely limited, and is not comparable with that of a detector operating with a negative grid bias, a negative grid biased detector is employed in this receiver. On any normal signal volume this will allow the substantially distortionless rectification which is vitally essential to good quality.

The detector tube can be very easily overloaded, however, if any endeavor is made to operate a loud speaker on any less than two stages of audio amplification. For this reason, the audio amplifier has no provision for using less than two stages. The signal volume control is located ahead of the detector. This means that if all local stations are adjusted to give substantially the same volume, the power input to the detector will be practically uniform and will be far below that necessary to overload it. At the same time, the power input to the audio amplifier will be uniform and the audio amplification characteristic will remain substantially constant—something that it would not do were the input power to be varied over a considerable range as would be the case were an endeavor ever made to operate a loud speaker upon a single audio stage or to control volume in the audio amplifier, after the detector tube.

The volume control used is a 25-ohm resistance in series with the filament of the radio-frequency amplifier tube. This type of volume control gives a minimum of detuning effect and impairs the quality of reproduction practically not at all. The proper location of any volume control in a radio receiver is before the detector tube.

This combination of a stage of tuned radio-frequency amplification and a non-regenerative grid-biased detector, will give ample selectivity and amplification for reception of local stations, and even for stations perhaps as far distant as 50 or 100 miles under good conditions. Yet, the amount of equipment used is very small, the simplicity of the circuit highly desirable, and the ease of tuning such that any member of the family with no knowledge of radio can operate the receiver without resorting to critical, hair-line, or vernier adjustments.

In any receiver designed for quality audio reproduction, the audio amplifier and the loud speaker used are vitally important factors. Quality reproduction starts at the transmitting station with the impression upon the microphone of the sound it is desired to broadcast and reproduce at the radio receiver. If the audio amplifier and loud speaker are improperly designed, the various frequencies will not be correctly amplified.

The audio amplifier used in the local receiver consists of two stages of transformer-coupled amplification using a 201-A tube in the first stage and either a UX-112, UX-171, or UX-210 tube in the second stage.

In the writer's article in the January, 1926, RADIO BROADCAST, he pointed out by means of curves and text the fact that the C voltage employed on either audio amplifying stage should exceed somewhat the maximum value of the impressed grid voltage. Thus, in the first stage of a transformer-coupled amplifier, where we will practically never encounter voltage variations in excess of one volt in a properly operated system, a negative grid potential of one volt would be entirely adequate to prevent excursions of the grid voltage over to the positive side of the grid-voltage, plate-current curve. Hence we will use approximately one volt negative grid potential obtained by virtue of the voltage drop across the master filament rheostat.

While such a low C battery voltage will result in a somewhat higher plate current for this tube than would be obtained with a lower value of C voltage, this is an indication of the exact condition we desire—a low plate impedance for the

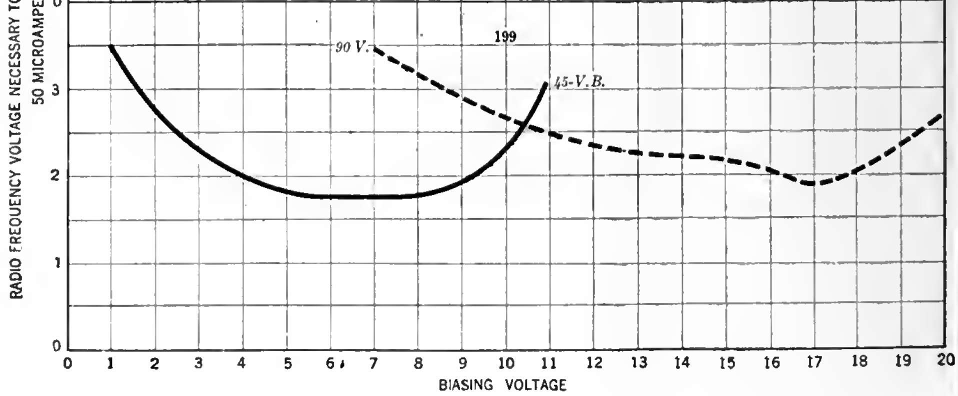


FIG. 2
Response curves of a C-battery detector for different values of plate voltage and C battery. The grid and plate voltages that give a change of 50 micro-amperes in plate current, with the smallest radio frequency voltage, are the best to use. From the curves it can be seen that best response is obtained with 45 volts on the plate of the tube and a C battery of approximately $3\frac{1}{2}$ or 4 volts

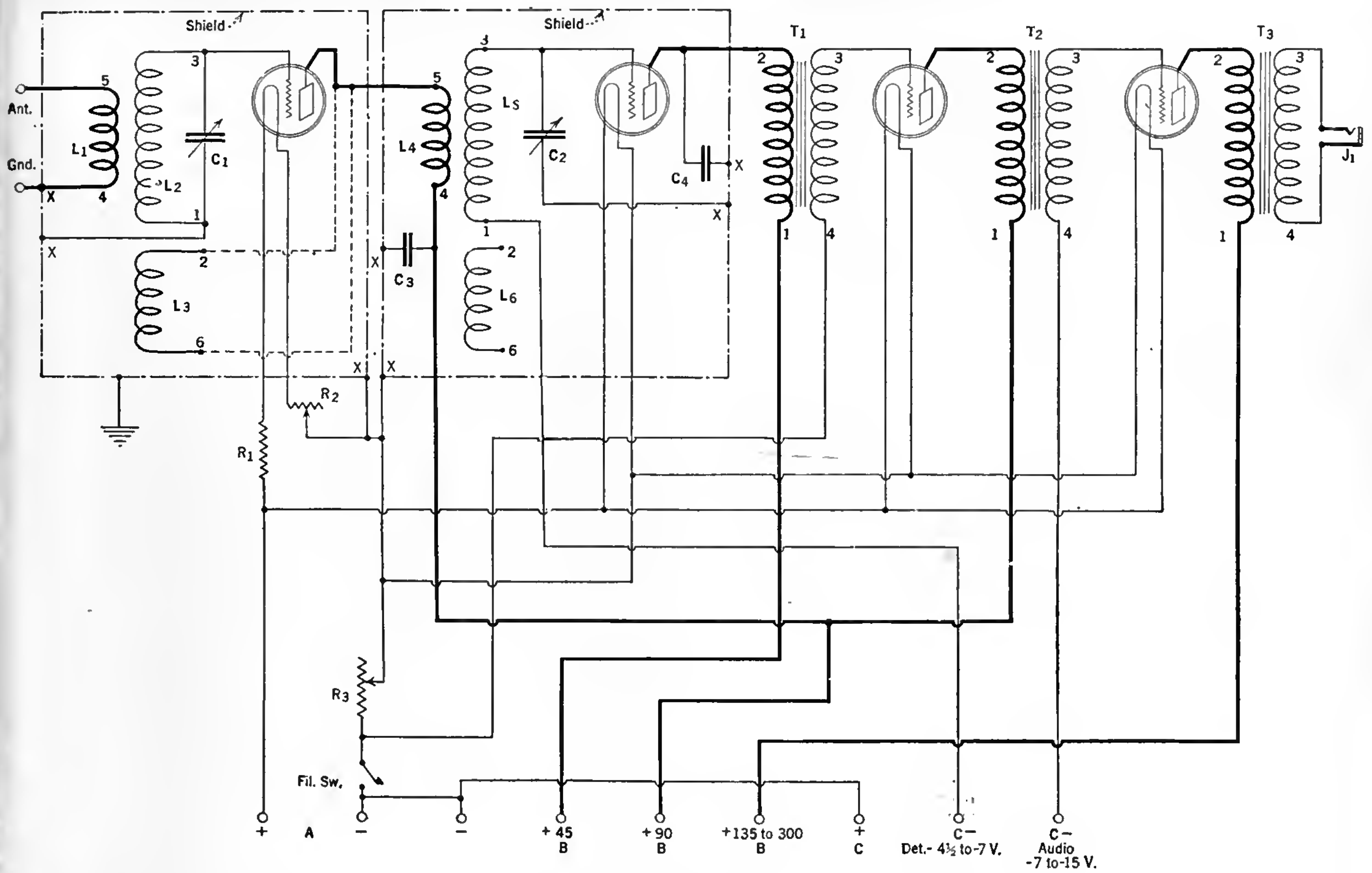


FIG. 3

The schematic circuit diagram of this RADIO BROADCAST "Local" Receiver. The receiver consists essentially of a stage of tuned radio frequency, a non-regenerative detector of the C battery type, and two stages of high quality transformer-coupled audio amplification. The various X's on the diagram indicate parts of the wiring that are grounded to the shields. The shields, indicated in heavy dash lines, prevent a certain amount of inter-stage coupling and also make the receiver somewhat more selective. The only tuning adjustments are the two variable condensers C1 and C2

tube. The lower the plate impedance of the tube, the more uniform will be our amplification over the entire frequency range, in a measure, and it is this effect, among other things, that the makers of power tubes are striving for.

In the second audio stage, a higher value of C voltage will be required. With a UX-112 tube operating on 135 volts plate potential, a negative grid bias of 9 volts will be required. In actual operation, the proper value of grid bias for the second amplifier tube should be very carefully adjusted by connecting a milliammeter (reading 0-25) in the tube's plate circuit. Then, with a strong signal being received, the C voltage should be very carefully adjusted to a point where the movements of the needle are at an absolute minimum, since this is the point of minimum distortion.

Since the handling capacity of any loud speaker is determined by the current which will cause saturation, it is essential that the direct current used to supply the plate circuit of the tube feeding the loud speaker be kept out of the speaker windings, since this plate current will represent in most cases several times the actual signal variation used to actuate the speaker, and since it serves no useful purpose in the speaker, but, on the contrary, will in time tend to demagnetize the permanent magnets used in its construction. A common method of accomplishing this is through the use of a 100-henry choke in the B-battery supply line to the plate of the last tube, together with a condenser 4 to 6 mfd. in series with the loud speaker, both connected across this choke.

One or two additional details of the receiver deserve attention. A single output jack connecting the loud speaker or headphones to the output transformer is employed. A three-ohm filament rheostat for adjusting the comparatively non-critical filament temperature of the four tubes is employed, together with an on-off switch for turning the entire set on and off.

THE PARTS WHICH CAN BE USED

A LIST of the parts used by the writer is given below, and it is suggested that, while "Local" receivers may be built in a number of different ways, the parts specified be strictly adhered to in building this particular outfit. If this list is adhered to, the author is practically willing to guarantee any builder practically perfect quality.

1—7 by 18 by $\frac{3}{16}$" bakelite front panel
1—7½ by 17 by $\frac{3}{16}$" bakelite sub-panel
1—pair S-M 540 mounting brackets
1—Yaxley 3, ohm rheostat—R3
1—Yaxley 25-ohm rheostat—R2
1—Yaxley No. 1 open circuit jack—J1
1—Yaxley No. 10 filament switch
2—S-M 316a 0.00035 condensers—C1 & C2
2—Kursch Kasch 4-inch dials, zero left
2—S-M No. 631 stage shields
2—S-M 515 coil sockets
2—No. 115 A coils—190-550 meters
4—S-M No. 511 sockets
1—Sangamo 1.0 mfd. condenser—C3
1—Sangamo 0.002 condenser—C4
2—S-M 220 audio transformers—T1 and T2
1—S-M 221 output transformer—T3
1—coil Belden flexible hook-up wire
6—½" x ¼" lengths brass tube for mounting coil sockets
1—Elkay Equalizer—Type 35—R1.

An assortment of $\frac{6}{32}$" round head screws and nuts, together with lugs.

If parts other than those specified above are used, care should be taken to make whatever changes necessary in order to permit the parts to fit into the circuit in the correct manner. The drilling template for the panel and sub-panel given in this article is laid out for the use of the parts given in the above list and will have to be changed if other units are used. The construction of the receiver will be very much simplified if a complete kit is purchased, since it will include all necessary parts, including the shields, which are drilled ready for assembling.

The home constructor may make up his own coils for use in the receiver. The construction of a home-made coil is shown in Fig. 4 and a very satisfactory receiver can be made up made in accordance with the specifications given in the figure. Fig. 6 shows complete data on the coils in the receiver described in this article. If forms are purchased, the coils may be wound in accordance with the specifications given in the diagram, or the coils may be purchased complete.

If the home constructor desires to make up his own shields, they can be put together by constructing a can 7¼ inches deep, 5 inches high and 3¾ inches wide. The top and bottom should be made separately so as to permit easy construction of the receiver. The cans should preferably be made out of aluminum, although sheet brass on copper may be used.

The panel may be laid out and drilled in accordance with the drawings accompanying this article. The bottoms of the two shields should

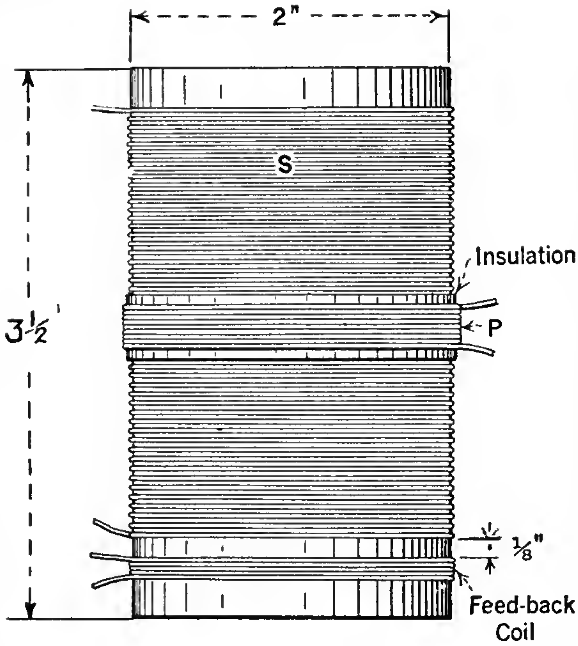


FIG. 4
Data for home-made coils The secondary is wound on a 2-inch cardboard tube and the primary is wound over the center of the secondary; the two windings being separated by about two thicknesses of cambric tape or other insulating material. The secondary should be space wound, but the primary should be closely wound so as to take up very little space. The feedback coil, wound at the filament end of the secondary, is only necessary if a 201-A type tube is used in the radio frequency stage. Complete data concerning the wire sizes and number of turns are given in Fig. 6

be mounted on the sub-panel with the rest of the apparatus, consisting of the coil sockets, tube sockets, transformers, bypass condensers and tuning condensers. The coil mountings connect directly to the sub-panel with the aid of the ¼-inch brass tubing. The condensers are mounted on the shielding, and to make sure a satisfactory contact is made, the rotor plates are also electrically connected to the shield.

WIRING THE OUTFIT

THE wiring is not especially difficult and it is somewhat simplified by the fact that no binding posts are used; the various external connections to the receiver are made long enough to connect directly to the battery circuits. In connection with the wiring, Fig. 8 will be found quite valuable, and if this picture is used in conjunction with the schematic diagram, Fig. 3, no trouble should be experienced. The coil terminals are indicated by numerals on the schematic diagram and in wiring the receiver care should be taken to be sure that the various contacts on the coil sockets are correctly connected into the circuit. In connection with the wiring, always remember that any lead which is finally grounded can be directly connected to the shield at any point. This fact will quite frequently make possible very easy wiring. For instance, since the negative lead of the detector tube filament is grounded, it is only necessary to run a short lead from the filament terminal of each socket to the shielding in order to connect the negative filament into the circuit. One side of bypass condenser C3 is grounded so that it can be connected directly to the shielding. In the same manner it will be unnecessary to run a lead connecting terminal 1 of the r. f. coil to the rotor plates of the condenser. Since the rotor terminals of the condenser are fastened through the sub-base, and thereby brought into contact with the shield, it is only necessary to solder a lead between terminal 1 of the coil socket to one of the mounting bolts of the coil socket in order to complete the circuit between the condenser and coil.

When all the apparatus has been mounted on the sub-panel and the connections made, the stage shield sides are slipped over the shafts of the two tuning condensers and are fitted into the bottom can. The panel is then screwed to the mounting brackets and two screws put through into the condenser mounting studs, one of which will be found on each condenser. This serves to fasten the entire assembly rigidly together and the tubes are really easily accessible in the stage shields by merely removing the top covers. In all of the wiring, leads should be connected to the different points by as short a path as possible. Since insulated wire is being used there is no danger from short-circuits. Practically all of the high-potential leads of the receiver are contained within the shields and, therefore, there exists very little possibility of coupling between the various parts of the r. f. amplifier and detector circuit.

PROPER USE OF PROPER TUBES

THE receiver as designed uses a type 199 in the r. f. stage, a type 201-A for the detector, and in first audio amplifier socket. This may be a UX-112 if the very best results are to be obtained. In fact it seems inadvisable to sacrifice any quality whatsoever when every endeavor has been made so far to obtain it. The second audio stage should be a UX-112 or preferably one of the new UX-171 tubes with the proper C voltage. With this arrangement, the filament current will be approximately 1.06 amperes. However, a type 201-A may be used in the r. f. stage, if it is so desired, and the only alteration necessary is to short-circuit resistance R1. This increases the filament voltage obtainable at the r. f. amplifier socket so as to permit the use of a 5-volt tube in place of a 3-volt tube. With a 201-A in the r. f. stage the filament current of the receiver will be 1¼ amperes which can easily be supplied by a storage battery. The advantage of using the 199 is that the tendency of the r. f. amplifier to oscillate is not as great as with the 201-A, and if a 199 is used, it is not necessary to connect coil L3 into the circuit. However, if it is desired to use a type 201-A tube, it will very likely be necessary to use coil L3 and it should then be connected between the plate of the r. f. tube and terminal No. 5 of the second coil as shown on the schematic diagram, Fig. 3. Then the small coil, together with the increased resistance effect due to the shielding, give a resultant amplification curve which is quite uniform over the entire wavelength range of the receiver. It is suggested that both arrangements be tried and in that way it will be possible to determine whether a 199 or 201-A tube gives most satisfactory results. When a 201-A is used, be sure to short-circuit resistance R_1, since if this is not done, the tube will not receive sufficient filament voltage.

It is suggested that a total B battery voltage of 180 be used on the last audio amplifier, when using the UX-171 tube although 135 volts will be ample for ordinary home reception when the UX-112 is used. With 135 volts the plate current will be in the neighborhood of 15 to 20 milliamperes; with 180 volts in the neighborhood of 20 to 25 milliamperes. While this current is not as low as might be desired, it is absolutely essential if

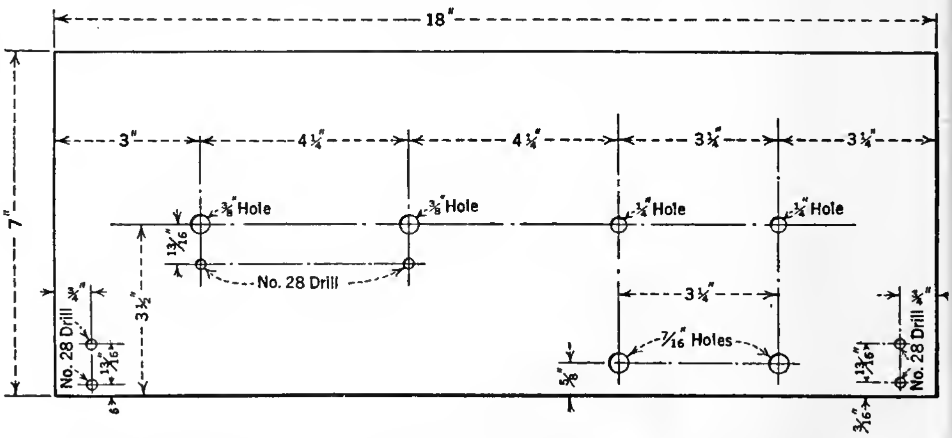


FIG. 5
The panel drilling template, to be followed if the same parts specified in the article are used

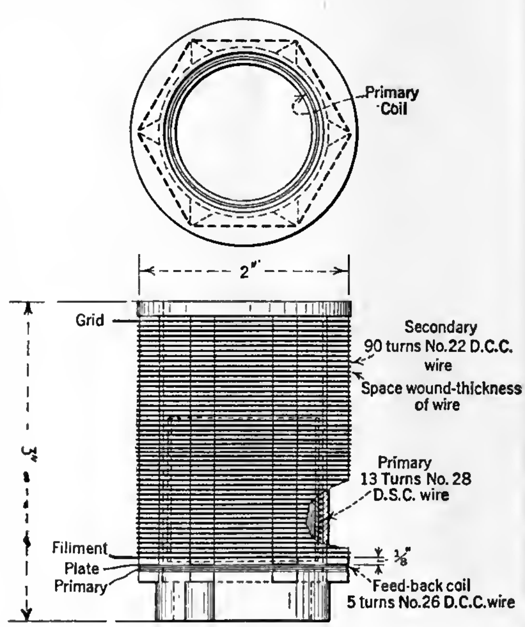


FIG. 6
Specifications of the coil. Any one desiring to make up coils exactly the same as those used in the receiver will find complete data in this diagram

quality reproduction is to be obtained; and it is assumed that the builder of this receiver is willing to go to some slight expense which will be amply repaid by the quality of reproduction obtained.

USING THE RECEIVER

AN ANTENNA of from 50 to 100 feet may be used with the receiver, either indoor or outdoor. The entire tuning of the set is done by the two large dials which read substantially alike for the different wavelength settings used for different stations.

The calibration chart shown in Fig. 7 will be found of aid in tuning, since if the frequency of the station you desire to hear is known, it can easily be located on the chart and the corresponding dial readings noted.

This chart is, of course, made up using the coils and condensers mentioned in the list of parts and will differ somewhat if home-made coils or some other type of manufactured coil is used.

The three-ohm rheostat at the right of the panel is first set with its arrow, which falls directly over the contact arm, pointing straight to the right, though it later may be set as far to the left as is practical without loss of quality in order to conserve A-battery current and tube life. The left rheostat should be turned all the way to the right for maximum volume and may be retarded to any desired position to decrease the volume for powerful nearby stations.

The proper value of detector C battery has been found to be between $4\frac{1}{2}$ and 6 volts for 201-A tubes at 45 volts plate potential. A curve indicating the variation of rectification efficiency with variations in C voltage for both 199 and 201-A tubes is shown herewith.

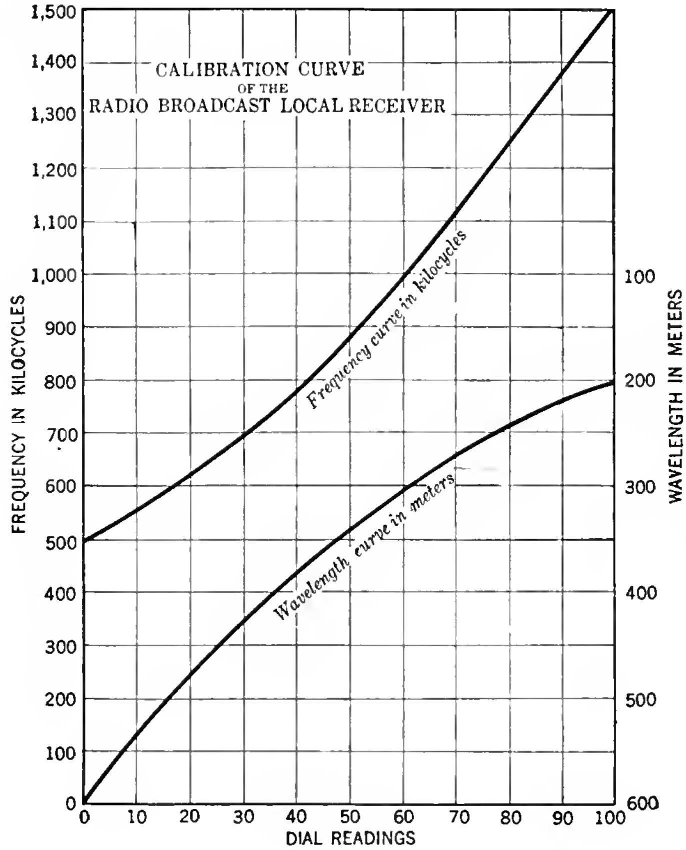
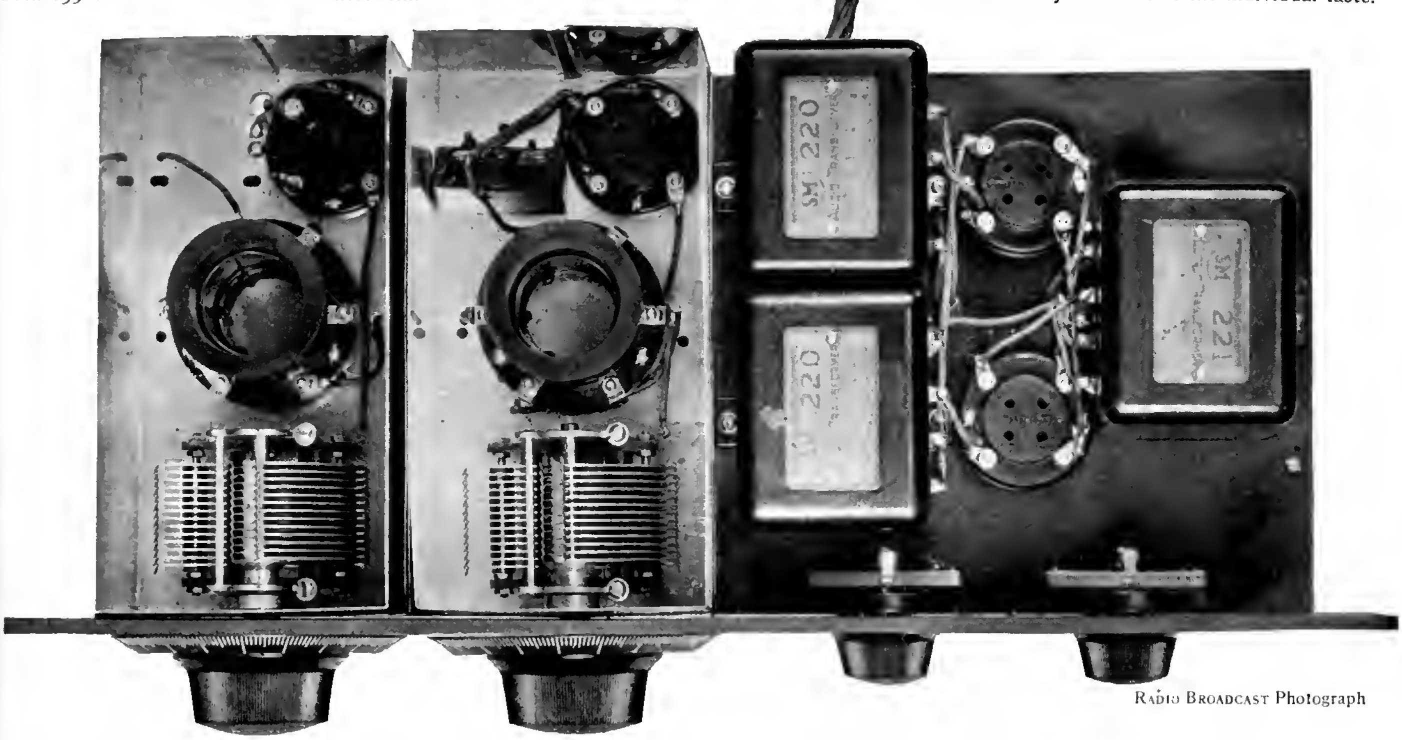


FIG. 7

A handy tuning chart, calibrated in both frequency and wavelength, to be used if the coils and condensers indicated in this article are incorporated in the receiver. If home-made coils are used, it is likely that the dial settings will be somewhat different

When more than average volume is desired, the writer cannot recommend too strongly the use of a UX-171 tube operating with 180 volts plate potential, or of a UX-210 tube with from 180 volts to 300 volts plate potential in the last audio stage. Such tubes will increase the power handling capacity of the amplifier to a point where the maximum volume simply cannot be tolerated in the average residence. If a UX-112 tube is used in the output stage at a 135-volt potential, there is absolutely no question but that it will be sadly overloaded if any endeavor is made to use the full volume output of the set. Therefore, if such a tube is to be used, the builder of the receiver must be content with a volume sufficient for the average large living room. If he anticipates operating the set at maximum power, then a larger tube with higher plate voltage must be used if quality is to be maintained. The required high voltages can be supplied by standard power supply units now on the market, as also can the filament lighting voltage for a UX-210 tube. This use of a large power tube in the last stage cannot be stressed too strongly and is, to the mind of the writer, vitally essential.

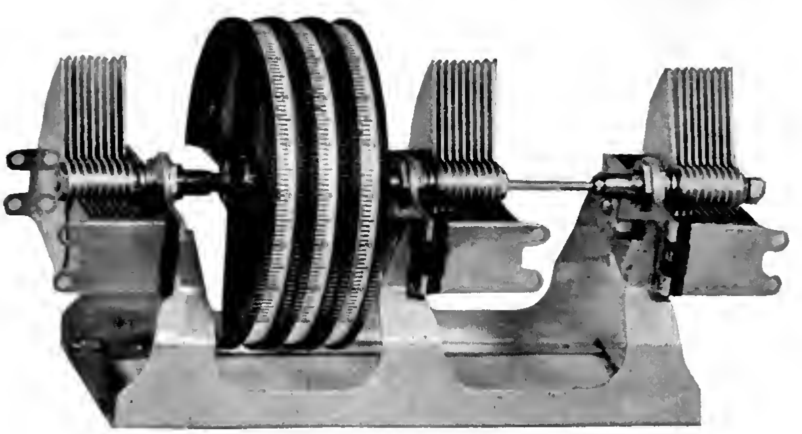
If interest is sufficient, a future article will describe methods of operating the Local Receiver completely from a standard type of power supply unit capable of an output sufficient to meet adequately the requirements imposed. Thus the Local Receiver could be entirely mounted in a cabinet with the power supply entirely self-contained so that it will be dependable in operation to the last degree—simple to a point where but a single switch need be thrown, the two dials set to any station desired, and the volume adjusted to suit the individual taste.



RADIO BROADCAST Photograph

FIG. 8

Looking down on the sub-base. Notice the arrangement of apparatus within the shields. The audio transformers are enclosed in metal cases, which prevents any inter-stage coupling that might otherwise produce howling



THE ALDEN "LOCALIZED CONTROL" UNIT

Each condenser may be tuned separately without holding the remaining dials. All three condensers may be turned simultaneously by placing two fingers on the center peripheries

Looking Ahead to 1927

The Second of Two Articles Discussing the Probable Trends in Radio Manufacturing for the 1927 Season—Reduction of Controls a Predominant Tendency—The Modified "Straight Frequency-Line" Condenser—Shielding Becoming More Popular—Automatic Variation of Coupling in R. F. Units

By ZEH BOUCK

THIS is the second and concluding article by Zeh Bouck on what the manufacturers will do the coming season. The first article, which appeared in RADIO BROADCAST *for July, covered the audio frequency developments, particularly in reference to the changes in commercial radio apparatus reflecting the use of the new power tubes. In this article, Mr. Bouck covers the radio frequency side of the question. Once again the writer's efforts have been twofold. The writer has tried to make the article of practical interest to the prospective buyer by means of detailed descriptions and prices; and to explain to the enthusiast, as far as possible, the theoretical significance of the advances in radio practice.*

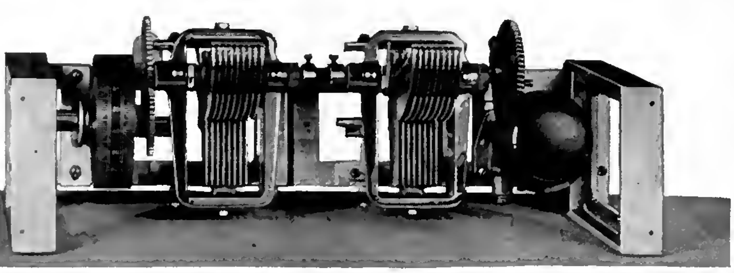
—THE EDITOR.

THE tendency to reduce controls by tandem tuning, which has been gaining more favor as it has solved its problems, is one of the predominant features of the 1926–27 tuning circuits. Tandem tuning refers to the mechanical linking of two or more tuning units. These units generally consist of united condensers, with rotors mounted on a common shaft revolving through individual stator plates built into a rugged, extended frame work. The isolated but simultaneously varied capacitances are connected to individual circuits—one, two, three or more r. f. stages, and detector. The problems associated with tandem tuning have been the matching of the various inductors and capacitances.

For really successful tandem tuning, it is essential that the inductance or coil effect of the different circuits, and the capacity or condenser effect, be the same at all frequencies (wavelengths). This means that, in complete sets employing tandem tuning, the stray capacity and inductance caused by wiring and the juxtaposition of parts, must be exactly the same in all radio frequency circuits, a balance that requires finesse only recently attained in the art of radio production. The use of vernier condensers can compensate for the discrepancies in stray capacity. But if employed to correct condenser or coil discrepancies, these are, in effect, additional controls, for the compensation differs for every setting of the main dial.

An appreciation of the difficulties involved in the tandem tuning of three individual circuits finds its expression on the part of the manufacturer in two ways—in the development of "localized control," and the design of receivers having two controls instead of one control.

The localized idea is perhaps most familiarly illustrated in the R. C. A. super-heterodynes. The oscillator and tuning dials, in the form of closely parallel drums, are so arranged that they may be turned together by a single motion of one hand. However, either dial can be turned separately, permitting those fine variations of a degree or two which are essential to efficiency on uncompensated circuits.



RADIO BROADCAST Photograph

A ROBUSTLY MADE TWO-"GANG" CONDENSER—THE PERLESZ

The two condensers are tuned simultaneously by means of a single knob. It takes seventeen rotations of the knob to reduce the condenser to minimum from maximum capacity, due to a special gearing arrangement employed. The condensers are of the s. f. l. type

A similar arrangement is available to the constructing fan in the form of the "Na-Ald Localized Control Unit," illustrated in an accompanying photograph. Three condensers of a modified straight frequency-line type are mounted concentrically, with shafts parallel to the panel, rather than perpendicular to it. The three condensers are not mechanically linked, and each is controlled individually by its respective dial. However, all three may be turned simultaneously by two fingers, placed upon the center peripheries. Scales reading from zero to one hundred, depressed in the rim, are supplied as standard equipment, but these are easily altered and such special designations as wavelengths, frequency, or call letters, can be substituted to suit individual needs.

The Alden arrangement is supplied in two and three "gang" (two and three condenser) units, selling respectively for $8.00 and $10.00. In the two-gang device, the extra shaft may be used to control a tickler coil, thus making the combination very suitable for the Roberts, Browning-Drake, and similar two-condenser regenerative receivers.

Another "localized control" unit is made by the Perlesz Company of Chicago. Its price is $55.00 without coils. It is shown on this page.

TWO HANDS—TWO CONTROLS

AS ALREADY intimated, a second system of circumventing the complications of tandem tuning, considers our natural manual endowments. We have two hands, so why go below two controls?—an argument not devoid of logic. Therefore, if we design a two stage r. f. receiver (such as the standard three-control neutrodyne), using a two-gang tandem condenser and a single condenser, or a three-stage tuned r. f. receiver employing two two-gang condensers, we shall have a receiver easily operated, and certainly one less complicated electrically than the same set designed as a single control arrangement.

Several new condensers specifically for use in receivers of this type, but, at the same time, quite applicable to single control systems, are being made. These condensers will be of the modified straight frequency-line type. The rotors will be electrically common.

Disdaining to compromise with lessened precision in the design of associated coils and circuits, Amsco Products are on the other side of the fence and are going into production on a four-gang condenser, especially designed for use in a single tuning control circuit, recently developed by Lester Jones. A combination of tuned and untuned r. f., through nine tubes (including detector and a. f.), makes the receiver operative from a small enclosed loop.

However, the difficulties of tandem operation have been carefully considered in the design of this four-gang unit. Small compensating capacitances form an integral part of the unit, and make possible the correcting of capacity discrepancies in the circuit. In other words, the condensers are "started right." Consistent resonance throughout the tuning range is assured by painstaking design and construction of the condenser unit itself. An unusual point of design in the Amsco four-gang arrangement is that the stators rather than the rotors are electrically common. The rotors are insulated from each other, and from the stator frame, with isolantite, And they are evenly distributed on each side of the frame and shaft, providing a true mechanical balance. The four-gang condenser will sell for about $25.00.

Many other manufacturers are responding to the market demand for ganged condensers. Allan T. Hanscom is manufacturing two and three condenser units retailing with dials at $15.00 and $20.00 respectively. Rathbun is putting out a single condenser that can be grouped in "gangs" of any number of units. This condenser, after the fashion of Rathbun, is of the straight capacity-line type, and is designed for use with their dial converter thus providing straight frequency-line tuning. The condenser itself being of the s. c. l. type, it requires less panel space than the average s. f. l. condenser.

Thompson Levering, precision machinists, are also making a balanced condenser designed for combination into "gangs."

THE GENERAL INSTRUMENT R. F. UNIT

All these parts go to make up the r. f. unit which is totally shielded. The top of the "can" is removable so that the parts, when wired, are readily accessible. The unit sells for $20.00

FREQUENCY, WAVELENGTH, AND CAPACITY LINES

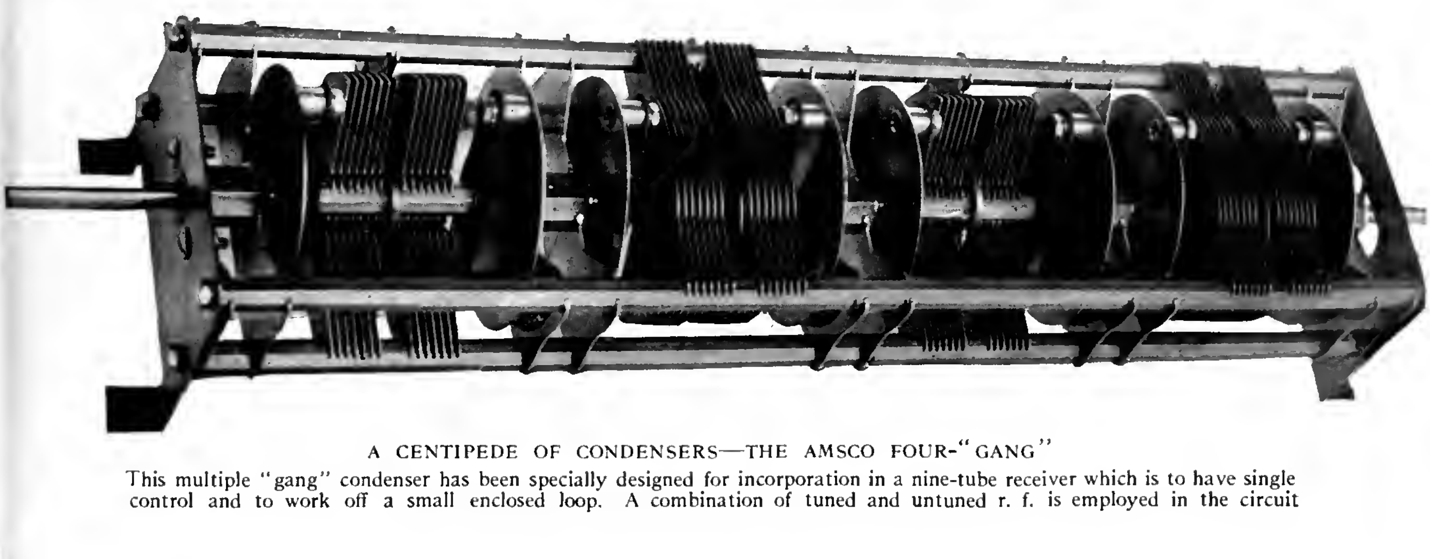
IT WILL be observed that some manufacturers are bringing out "Modified Straight Line Frequency" condensers. (Or, rather, it is more correct to say "modified straight frequency-line condensers." Frequencies are not characterized by lines. However, there is such a thing as a "frequency line," which refers to the line of resonant frequency plotted against capacity variations in a tuned circuit.) These modified condensers are designed to give a straight frequency-line effect on the shorter waves and something approaching a capacity-line effect on the longer waves. It is interesting to consider this movement. It seems to be in answer to a demand on the part of the consumer who, changing from straight capacity-line condensers, which spread the upper wave stations and cramp the lower, to straight frequency-line condensers which separate the stations equally over practically the entire tuning range, has found it difficult to become used to his new condensers. To his empirical mind, the straight frequency-line condensers seem to cramp the upper wave stations and spread the lower waves, and he demands a combination of the two condensers as an ideal arrangement. Actually, the modified condensers give an exaggerated spacing between the longer wavelength stations. As long as the government continues to allocate stations at ten-kilocycle intervals, the proper way to tune for them is by a condenser giving as closely as possible equal frequency variations per degree of dial movement—in other words, by means of straight frequency-line condensers.

In passing, it might be well to mention that the substitution of s. f. l. condensers for other types of the same capacity and electrical efficiency in no way affects the operation of the receiver other than in the readjustment of the dial settings. The receiver will work no better and no worse; selectivity will not be affected, except in so far as it is affected by convenience in tuning.

SHIELDING

ANOTHER interesting development that is assuming commercial proportions this season, is the shielding of radio frequency circuits. Mechanically, shielding consists of placing all radio frequency elements in a can, generally of copper. In other words, all parts of each r. f. stage, input coil, secondary, tuning condenser, and tube, are completely inclosed in the shielding material. Partial or localized shielding is comparatively ineffective, being efficacious only against simple stray effects.

The idea of shielding is to make the



A CENTIPEDE OF CONDENSERS—THE AMSCO FOUR-"GANG"

This multiple "gang" condenser has been specially designed for incorporation in a nine-tube receiver which is to have single control and to work off a small enclosed loop. A combination of tuned and untuned r. f. is employed in the circuit radio frequency currents and fields behave —go where they are supposed to go and nowhere else. The helter-skelter distribution of an electric field, which spreads out from every wire carrying current, is responsible for many radio ills. Due to these fields, radio frequency impulses have a tendency to jump from the antenna and intermediate circuits to the detector circuit without going through the r. f. amplifying tubes, thus escaping the amplifying action. Also, these renegade currents may have such a phase relation with the legitimate amplified impulses as to "buck" them with a general debilitating effect. And again, other impulses originating in the neighborhood of the detector circuit will often find their way back to other circuits by this same road of uncontrolled fields, rendering the entire system unstable even to the extent of self-oscillation.

Correct and complete shielding practically eliminates these stampeding fields. All pickup is confined practically to the antenna system, and forced through the amplifying circuits, achieving a genuine "cascade" effect—each stage amplifying the output of the step immediately preceding.

The General Instrument Company is manufacturing a shielded r. f. unit, comprising tube socket, stabilized coils, and tuning condenser. The "can" opens at the top to permit the changing of tubes. The entire unit, which can be mounted behind the panel, sells for $20.00 with dial.

Hammarlund and Silver Marshall are also manufacturing shields for enclosing individual r. f. systems.

The Sickles Coil Company are making a shielded radio-frequency transformer selling for about $2.50. While, as intimated before, shielding only the coil is not so efficacious as protecting the complete r. f. unit, it admits of much greater freedom in the placing of the coils and adjacent parts. No attention need be given to coil angles, and a much more compact arrangement is possible.

Shielding is hardly worth while in a single r. f. stage. Indeed, it is seldom beneficial when less than three radio frequency steps are employed. On one and two stages, the concomitant losses of shielding are rarely compensated by the advantages gained. However, on three or more steps, it is practically a necessity, contributing greatly to overall efficiency.

R. F. CHOKE COILS

RADIO frequency choke coils perform a function somewhat akin to that of shielding, and are designed to keep r. f. currents within bounds. In parallel feed oscillating circuits — such as are often employed in short-wave reception—and in many super-heterodynes and reflex arrangements, these coils vary from a desirable addition to a necessity. Their specifications in several comparatively new and complicated circuits, has stimulated their manufacture on a commercial basis by the Samson Electric Company (types 85 and 125) and Silver Marshall. The Silver Marshall r. f. choke retails for $1.00 and the Samson, models 87 and 125 respectively, at $1.50 and $2.00.

VARYING ENERGY TRANSFER

IN ANY radio-frequency amplifier, it is impossible to obtain maximum efficiency unless the coupling between primary and secondary is varied at different frequencies. In the average radio-frequency amplifier, the system is arranged to provide efficient energy transfer only within a limited band of waves. As a result, sensitivity (and often selectivity) is impaired on the other waves. An ideal arrangement would enable the coupling between primary and secondary to be varied with dial changes so that transfer would be at its optimum value at every frequency.

The Zenith Company of Chicago, and other manufacturers of complete sets, have been employing the Lord system of energy transfer adjustment for some time. The Lord device comprises an r. f. transformer with a split primary functioning after the manner of a variometer. The shaft of the variometer is linked, by means of a projecting axis, with the tuning condenser across the secondary. As the one tunes lower in frequency, the variometer action reduces the effective coupling between primary and secondary with a desirable and corresponding reduction in the energy transfer factor. The concomitant lessening of the inductance of the primary also contributes to this condition.

The Lord system is being made available to the constructing fan by the Hammarlund Company, who are making r. f. transformers of this type to retail at $2.50.

The King system achieves a similar variation in energy transfer between primary and secondary in a different manner, to which a later article will be devoted. Kits and parts for use in various circuits to which the King arrangement is applicable will be featured in the Karas line this coming season. A side light on the King device which makes it particularly interesting to the less experienced fan, is the simplicity with which it lends itself to the construction of a single-control nonradiating three-circuit regenerative receiver.

It should be observed that both the Lord and King arrangements require condensers with extending shafts—a condition that has been met inadvertently by the manufacturers of condensers designed for "ganging."

COILS

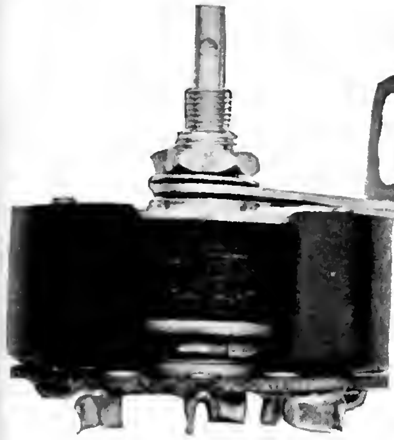
THERE have been few changes in coil design other than a continual trend toward unusual shapes brought about by the desire for a coil of reduced external magnetic fields. It will be remembered that these are the troublesome fields, to control which shielding is resorted to. As coils approach the toroidal or "doughnut" form, the external field is reduced, and similarly, their susceptilibity to stray fields. The toroid is practically a self-shielded coil as far as magnetic fields are concerned. Unfortunately, the efficiency of these coils — the ratio of inductance to resistance — is comparatively low, and compromises between shielding effects and efficiency result in such coils as the Grebe binocular coils, and similar arrangements.

"Doughnut" coils are being manufactured by Bremer-Tully, and similar inductors are used in the various "Thorola" receivers.

Silver-Marshall have brought their standard plug-in inductors to a higher stage of perfection. These are now wound with spaced turns of enameled wire. The r. f. transformers are provided with reversed feedback windings for stabilization. These coils are made in sizes covering frequencies of 167 to 10,000 k.c. (wavelengths from 30 to 1800 meters), the various coils being plugged-in to a standard coil socket. The broadcast range coils (type A) sell for $2.50, and the sockets for $1.00 apiece.

The American Mechanical

THE THOROLA MODEL 59 RECEIVER
It is equipped with toroidal coils which have become very popular due to the fact that they have little or no external magnetic field, and therefore may be placed close to other apparatus without ill effect



THE "CLAROSTAT"

The side has been cut away in this photograph so that the essential parts of the interior may be seen. Mica and carbon particles are compressed to give lower resistances. It is made by the American Mechanical Laboratories

Laboratories are introducing improved models of the "Clarotuner." These are radio frequency coils designed for use with Roberts, Browning-Drake and three-circuit receivers. The tickler coil is fixed, regeneration being controlled by a variable shunt resistor. As the resistance is lowered, a gradual short is imposed across the tickler, and regeneration is reduced. The advantage of resistive controlled regeneration lies in lessened effect of the regeneration control on tuning, as compared with the usual retuning necessitated by varying the coupling between the conventional tickler and the secondary it feeds back to. The Roberts type (2RK) "Clarotuner" sells for $7.50, while the three-circuit arrangements retail at $4.50.

The Sickles Diamond Weave Coil Company have developed a highly efficient inductor for the RADIO BROADCAST "Aristocrat" receiver. It is a modification of their standard Roberts coil with the N and P coil so arranged as to give a greater energy transfer at the higher wavelengths, at the same time reducing the capacity between primary and secondary—changes in design which are highly desirable and contribute to the overall efficiency of the coils. The "Aristocrat" coil sets sell for $8.00.

RESISTIVE STABILIZATION

THE resistive stabilization of radio frequency circuits has caught the popular fancy, and several manfacturers have developed improved variable resistors especially for this purpose. Stabilization by means of a variable resistor is most efficiently obtained by placing the variable element in the plate circuit of the r. f. amplifier. So placed, the cutting-in of resistance lowers the plate voltage applied to the r. f. tubes, increasing the plate-impedance, with a lowered transfer of fed-back energy (which is the cause of instability). At the same time, less energy is available across the r. f. primary to feed back. Thus, by means of the variable resistor, the r. f. system can be maintained a little below the oscillation point—in other words, at a high degree of amplifying efficiency—throughout the tuning range. A 0-200,000-ohm resistor is generally employed for this purpose on a standard two-stage tuned r. f. system. The Electrad Royalty, types B and C, at $1.50; the Centralab No. 200M at $2.00; and the Clarostat at $2.25, can be employed effectively in this arrangement.

INDUCTOR AND SOCKET

As manufactured by the Silver-Marshall Company. These coils may be obtained in various sizes to cover from 167 to 10,000 kc (30 to 1800 meters)

MORE ABOUT TUBES

AS MENTIONED briefly in the July article, several tubes contributing to efficiency in radio frequency circuits have recently been put on the market. The R. C. A. 200-A, and the Bristol-Donle tubes are gaseous detectors, and both exhibit a sensitivity to weak signals greater than that of the 201-A type bulb. Of the two, the writer has found the Bristol-Donle to be the more sensitive. However, the Radio Corporation model seems to be less critical and easier to operate, functioning with almost equal satisfaction on any plate potential between 20 and 40 volts. The R. C. A. and Bristol tubes sell respectively for $3.00 and $5.00.

The Cleartron r. f. tube, retailing for $2.50, has been especially designed for radio frequency amplification, where its amplification constant of ten is said to be remarkably effective.

Apco is bringing out a new double filament 201-A type of tube, selling for $2.00. A small switch on the bottom of the standard Navy type base transfers one of the filament prongs to either filament.

MISCELLANEOUS DEVICES

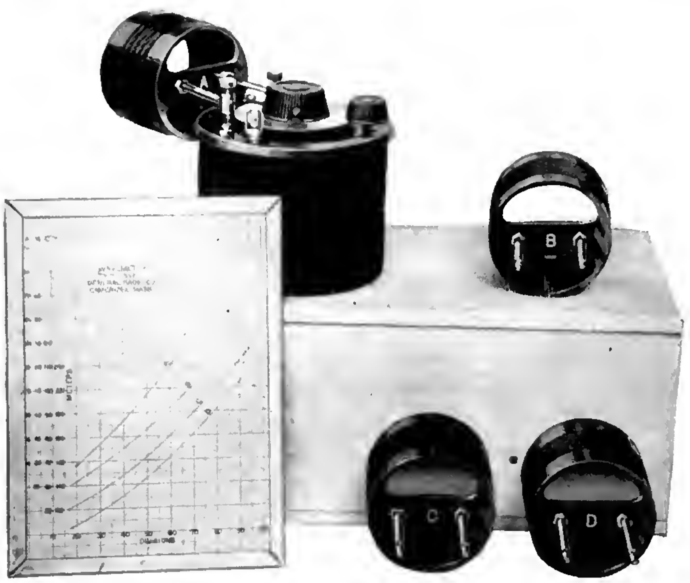
ASIDE from the mentioned items affecting directly the electrical efficiency of the radio frequency circuits, many new devices will appear on the fall and winter market contributing to the general utility and convenience of radio apparatus.

The "Dyal Quietron Cap," is a useful and simple "gadget" selling for fifty cents. It is a heavy, hollow, metal hemisphere, that fits over the top of a 201-A size tube. Its weight adds to the inertia of the tube, lowering its period of mechanical vibration and practically eliminating microphonic howls. The loud speaker can be operated close to any receiver when the detector tube, and such others as may be responsible for vibratory feedback, are capped with this logical if simple "Quietron." Bremer-Tully have manufactured, for some time, a device which clasps the tube to cut down vibration effects.

The Karas Electric Company have developed one of the most efficient vernier dials that the writer has seen. It is known as the Karas "Micrometric," and is a gear-driven dial with a ratio of 63 to 1. The gears are so designed that there is absolutely no backlash. Rough tuning is accomplished by a large knob, and vernier adjustments by a smaller knob. The dial

AN ELECTRAD RESISTOR

Of the "Royalty" type. It may be utilized effectively for controlling regeneration in r. f. circuits



THE GENERAL RADIO TYPE 358 WAVEMETER

It will have a direct appeal to the fan who is going in for short-wave work. It has a range of from 1250 to 21,426 kc. (14 to 240 meters), and features a resonance indicating lamp

is 4½ inches in diameter, and the scale marking, in ½ degrees, can be obtained in gold or white inlay. The price is $3.50.

Rathbun have improved their straight frequency-line convertor. This is an ingenious dial selling for $3.50, arranged with a form of differential gearing which makes any straight capacity-line condenser tune as a straight frequency-line instrument in respect to the dial motion.

THE KARAS "MICROMETRIC" DIAL

It is a gear-driven dial with a ratio of 63 to 1. Rough tuning is accomplished by the larger knob while the smaller knob is for vernier adjustment

For the benefit of the many satiated fans who are turning to short waves and code work as a relief to their ennui, the General Radio Company has designed a new wavemeter which retails at $20.00. The general appearance of the 358 meter is reminiscent of the older type 247W. The coupling coil of the latter, however, has been dropped, and a resonance indicating lamp has been added to the newer instrument. The range is 1250 to 21,426 kc. (14 to 240 meters), and is covered by means of four coils. An individual calibration chart is supplied with each wavemeter.

Hanscom Radio Devices are marketing a novel arrangement known as the Hanscom "Set Tester." This is nothing more than a transmitting wavemeter covering the broadcast band. No batteries are used, the instrument drawing both plate and filament potential from the 110-volt a. c. line. This device will transmit a signal over at least fifty feet to practically any receiver, and is most useful for calibrating sets, determining their wavelength range, and sensitivity. The tester sells for $10.00.

Rathbun has developed a wave trap selling for $5.00, that is particularly recommended to enthusiasts suffering from code, super-power, and other types of tunable interference.

The Acme Wire Company is continuing and supplementing its excelent line of wiring products. "Celastite," the wire with the non-inflammable spaghetti insulation, will be available in 25-foot coils of flexible wire, as well as the more usual bus bar lengths. Stranded enameled antenna, wire, loop wire, and non-inflammable spaghetti tubing, are an additional contribution to convenience and efficiency.

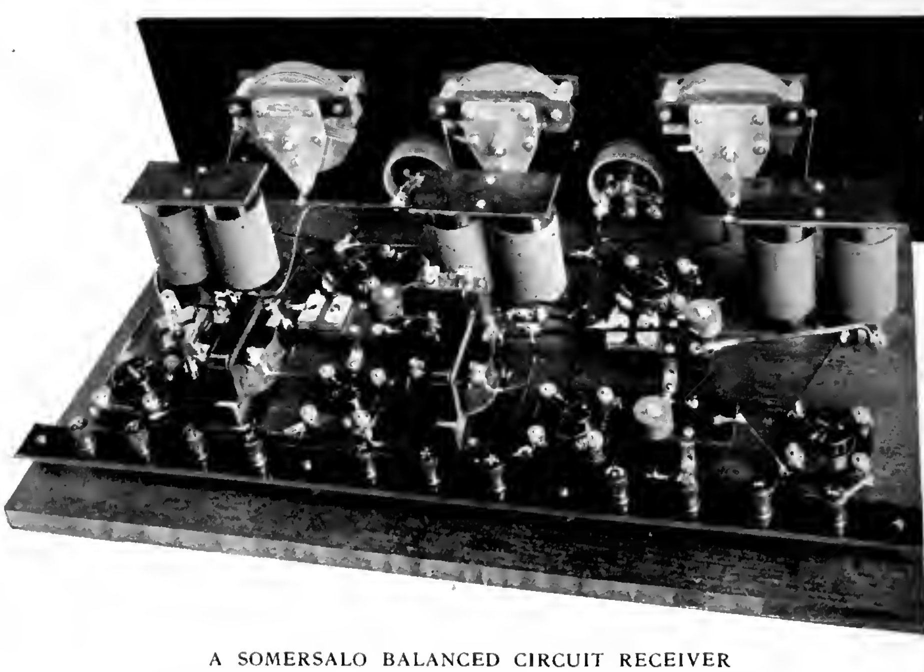
Still exhibiting the influence of the new power tubes, the National Carbon Company is modifying the Eveready 768 battery (a 22½-volt portable B supply.) Taps will be added, making it suitable as a C battery for use with the UX-171 output tube. Employing from 90 to 180 volts on the plate, this tube is the most efficient power tube available to the fan, but requires a C potential higher than those applied to the grid of the 201-A or 112 tube. The new battery will still be known as the 768, and will sell for the same price, namely $1.50.

THE NA-ALD SOCKET STRIP

This strip is obtainable in various lengths to accommodate any number of tubes. It costs fifty cents per tube length

Several new cushion sockets are making their appearance. The Amsco "Floating" socket is supported on four coiled springs combining a genuine cushion effect with unusual ruggedness. The "Floating" socket sells for $1.00.

Na-ald is also featuring an excellent vibrationless socket. In addition, they are making strip sockets, taking any number of UX or CX tubes—at $0.50 per tube. In brief conclusion, the coming radio season should be a most prosperous one. We venture to prophesy that the ratio of bankrupt fans to bankrupt radio concerns will be raised to an appalling degree.



A SOMERSALO BALANCED CIRCUIT RECEIVER

In which "binocular" coils, a toridal compromise, are used. These coils, due to their form, are partially self-shielded, thus obviating, to a certain extent, the necessity for metal shielding

Conducted by – John Wallace

Where Are the Rewards for American Radio Musicians?

THE British Broadcasting Company (the source of all broadcasting in Great Britain) has recently offered an important opportunity to all younger and lesser-known composers of British birth. It proposes to hold in London in the Autumn of this year a great Musical Festival. Prizes amounting to £1000 will be awarded for original musical compositions which will be performed at this festival and afterward will take their place in regular broadcast and concert hall repertory.

The young British composer has in the past suffered not only from lack of opportunity for gaining a first public hearing, but also from the difficulty in securing the publication of his work; without such publication it is, of course, impossible for conductors and concert managers to judge the merits of the composition. The offer made by the B.B.C. in coöperation with the Oxford University Press, is, it will be seen, a double one, and ensures not only a worthy first performance before the vast radio audience, but also publication under the most favorable auspices.

WARNER BROTHERS RADIO STATION

A striking night view of KFWB, at Hollywood. The administration building of the company and the twin 150-foot towers of this 500-watt station are effectively illuminated by the many Kleig lights

The variety of composition invited is shown in the list of prizes offered:

(a) A work in Symphonic form—Symphony, Poem (in 3 or 4 movements), or a Symphonic Suite—lasting not less than 25 or more than 45 minutes Prize £300

(b) A short work for Chorus and Orchestra (solo voices optional), lasting not less than 20 or more than 45 minutes Prize £250

(c) A Symphonic Poem or a work in Overture form (one movement), lasting from 10 to 20 minutes Prize £150

(d) A poem for Voice and Orchestra (with or without words) lasting from 8 to 15 minutes Prize £150

(e) A work for Military Band in one or more movements, suitable for performance by the ordinary Military Band Prize £100

(f) A Song-Cycle for one or more voices with not less than 3 solo numbers Prize £50

This move on the part of the B.B.C. we consider a most praiseworthy one. It is altogether fitting and proper that radio be instrumental in bringing to composers the fat and handsome profit that is their due.

In the course of the lengthy controversy that has been waging during the last couple of years on the question of copyright laws we have held to only one decided opinion. And that is that whatever way the thing be settled, and no matter how many other factors may enter in, in some manner or means it should be contrived that the musician reap the major part of the profits resulting from the twentieth century's latest invention.

To every dog his day! And this should be the musician's day. Of course it isn't; the money is being made by the manufacturers of radios, radio parts, and accessories, and in some instances by the operators of toll stations. Evidently these men are entitled to some of the gold for their work in making radio and broadcasting what it is. But the fact remains that, while radio would be impossible without radio receiving sets, it would be likewise impossible without music, which constitutes about eighty per cent. of program material.

The age old economic principle of Demand affecting the price of Supply should hold. The supply of musicians, considering the death rate and the output of the conservatories' as equal, is exactly what it was five years ago. In the course of those same five years the demand for music has increased in amazing proportions. We think it is little exaggeration to say that the demand for music has increased an hundred fold .Formerly the only music a man heard, week-in-week out, was the church organ on Sunday, or his daughter's practice hour when he got home too early, with maybe a couple of phonograph records thrown in on Saturday night. Now he hears several hours of assorted music a week. And his tribe has increased and continues to increase daily.

GUSTAV KLEMM

Conductor of the WBAL Concert Orchestra that broadcasts a "twilight program" every Sunday evening

And so, if a hundred cubic feet of music is being heard now to the one cubic foot that was heard in 1920, it seems only reasonable, if the law of Supply and Demand hold, that each and every musician in the country should have an income approximately one hundred times as large as it was five years ago.

That may sound ridiculous, certainly it sounds impossible, but, we repeat, give the dog his day! The musician has been the under-dog long enough. In the cycle of time he may soon be the under-dog again. So let him gather his rosebuds while he may. (Perhaps we mixed that metaphor: the average dog doesn't pick flowers). His position, with the advent of radio, was not unlike that of the khaki cloth manufacturer at the time the war started. Both suddenly found a hundred men using their goods where one had used it before. The khaki cloth manufacturer now has an estate on Long Island and a swimming pool in Florida. And so we say to the musician, profiteer, profiteer, and profiteer! Turn down the screws as tightly as you can and gather in all the sheckels you can squeeze, directly or indirectly, from your new found public!

But the proper subject of this discourse, from which we seem to have strayed, is the encouragement, by radio, of native talent. Perhaps some American station has sponsored a similar prize contest that we have not heard of. At any rate one should be undertaken, and, considering the relative wealth of two countries, the prizes offered here should be considerably in excess of £1000.

We do not mean that radio in the United States has ignored home talent. Probably every station has at some time or other made remarks on the subject. We remember some "All American Programs" from WBAL. WLW, during American Music Week featured American compositions. KFI presented an Artist-Composer series in which composers were heard in interpretations of their own works. In this series appeared Cadman, Grunn, Gilberte, Tandler, Ross, Barbour, Bond, and others. WEAF has, since last February, presented a regular Tuesday night feature called "A Half Hour with American Composers" which has introduced to the populace several important musicians and many lesser lights.

To sum up these random remarks, we think that radio owes a very definite and unescapable debt to the musician and should seek every opportunity to assist him. Our motto: A Rolls Royce for every Piccolo Player.

What the Farmer Listens To

THE National Farm Radio Council has been making a nation-wide survey of farms where radio sets are owned, to find out just what the farmer wants to hear over the radio. The basis of this survey was a questionnaire of eighteen questions. Twenty-five thousand of these questionnaires were sent out directly to farmers by the National Farm Radio Council and many thousand more by other coöperating agencies such as agricultural publications, radio stations, and agricultural colleges. The resulting information, based on tabulation of 44,550 individual answers, has been compiled in an elaborate booklet, a copy of which we have recently received.

The average urban listener doubtless has the impression, as had we, that the farmer is most interested in having himself uplifted and educated—for the reason, no doubt, that every program we hear announced as a "special feature for farmers" is of such uplifting or educating nature. But lo and behold! it seems the tired farmer, just as the tired business man, is more eager to be entertained by his radio than taught.

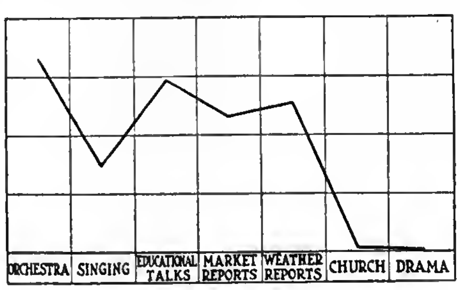
According to the survey, orchestra or band, educational talks, weather reports, market reports, and singing are the features with the greatest appeal. But first place is won by the orchestra, with farm talks trailing in second. Weather reports and market reports have about the same general appeal. A wide decline of interest is registered regarding vocal efforts.

Some slight interest in church services and in the broadcasting of plays was shown. Other features did not excite sufficient interest to be charted. Under educational talks were classified talks by farm leaders, talks by agricultural production and marketing experts, convention speeches and the like.

While the orchestra and band were given first place, there was a general objection to jazz and a general demand for more Hawaiian and old time music. Vocal selections were not popular and those who wanted vocal were carefully discriminatory. Male voices were preferred, particularly male quartettes. A soprano voice found general disfavor among farm radio audiences.

In some sections where radio stations have developed their own dramatic talent and real radio dramas are broadcast from the studios, genuine interest and approval was registered. News bulletins were in general demand.

Radio as an important factor in the marketing of farm products was illustrated in the National Farm Radio Council survey by specific reports from 43 states. An amazing total of 46 per cent. of the replies gave specific examples of cash savings effected by the use of radio. Practically every report indicated the importance and value to the farmer of having market reports from 24 to 48 hours earlier than they are available through any other medium.



HOW PROGRAM FEATURES APPEAL TO THE FARM FAMILY

In a survey conducted by the National Farm Radio Council, 7618 expressions giving the relative importance of ten different types of program features were analyzed and tabulated. The chart above shows the result

MILTON CROSS

One of the veterans of the staff of WJZ who announces most of the important musical events broadcast from that station

A graphic account of just how this market information serves the farmer we cull from another source—a survey made by Kenyon W. Mix, representative of a New York radio manufacturer:

A hog buyer from Kansas City visited a farmer at 9 o'clock one morning and offered him a certain price for a quantity of his hogs. The farmer and his wife demurred, complaining that the figure was too low. The buyer excused himself and rode off to another farm.

Two hours after the farmer tuned his radio set and caught the 11 o'clock market quotations. The broadcast price for hogs was below the one offered by the departed buyer, so the farmer did some quick thinking. He knew the man was at another house a few miles up the road, so he called up by telephone, got in touch with him, and after saying that he needed some money and had decided to sell at the quoted terms, he closed a profitable deal. The buyer did not know of the sudden price change, and was held to his original quotation by the ethics of the business.

In another case I met a farmer who had for a neighbor a man he intensely disliked. The first farmer had a radio set, and the neighbor didn't. One day, while the former was listening to his receiver, he learned that the price of cabbages had gone up $20 a ton. Thereupon he went out, bought from his neighbor all the latter's available cabbage, at the old and lower price, of course, and then resold at a healthy profit. The other man now also has a radio receiver in his living room.

Can you hold with us for some further statistics? We have at hand the report of another survey which is interesting in that it so closely corroborates the above. This is a survey of more than 18,000 farm homes which is being made by the farm women themselves, under the guidance of Mrs. Mary C. Puncke, of the Sears-Roebuck Agricultural Foundation. The results were gathered by some twelve hundred observers, each of whom studied carefully the conditions in a small group of homes in her own neighborhood. These are some of the conclusions:

Although the silver tongued salesman may sell the farmer his radio set as a business investment, once it is installed in the home, its chief function is entertainment as far as the man of the house is concerned.

Twenty-five per cent. of them prefer music to any other program; 24 per cent. are making the most of the practical side of radio, using them regularly to get the daily weather and market reports. This is especially true among corn belt farmers, in Iowa, Illinois, Missouri, Indiana, and Ohio, where 42 per cent. state that they rely almost entirely on weather and market information which their radio brings them. Down in the cotton country, both east and west of the Mississippi, farmers still prognosticate coming weather events by the look of the sky and the smell of the wind; 3 per cent. only give this as an important feature of their radio programs.

Church and sports by radio make little appeal to the farmer, according to his wife's report on him, and he still prefers to get his political opinions, first hand, at the general store. Farm women, as a rule, like the household home makers' programs best, for 41 per cent. tune-in on these most frequently. Thirty one per cent. prefer musical programs, 8 per cent. want lectures; 1 per cent. are especially interested in farm talks on gardens and poultry and 3 per cent. enjoy their radio most for the church services and sacred music it brings them.

The thrifty housewives of New England poll the largest vote for the home makers' hour, with its hints on economics and new recipes; corn belt farm wives run them a close second, probably due to the circumstances that these two sections are close to stations which specialize in programs of help and interest to rural homes.

Farm women in the tobacco lands, Kentucky and the Virginias, will tune-in on anything, just so it is music, and they likewise are the most enthusiastic about church and religious programs. Women in the cottom growing states west of the Mississippi, like their husbands, enjoy the serious, educational programs; 37 per cent. will always fish around in the ether after a lecture.

But farm folk, on the whole, are not prone to be fussy about the kind of entertainment they can get over the air; 18 per cent. of the men and 16 per cent. of their wives refuse to state a preference, because they like it all so well.

The most radios are found in the New England States, New York, and Pennsylvania where they have invaded 38 per cent. of the homes. The central corn belt, Iowa, Missouri, Illinois, Indiana, and Ohio, run a close second, 33 per cent. But the Eastern cotton states should be the radio salesman's paradise, for radio has found its way into only 3 per cent. of the homes.

Checking Up the Announcer

AS WE have said before in this department, we do not think that radio will ever amount to much as a medium of education. But we made at the time an exception: we thought, and still think, that radio can do some little missionary work in the line of disseminating correct pronunciation of the English language. This can be done by the most fundamental mode of pedagogy—example. Many terms—particularly musical ones—which the average man hears on the radio, he hears nowhere else. Hence his pronunciation of these terms is guided absolutely by that of the announcer. So convinced are we that the announcer wields a considerable influence in the matter of pronunciation, that we believe that if by mutual connivance all the announcers in the country mispronounced even some very simple word for two weeks straight they could dupe the whole nation into so pronouncing it. So we are interested in the pronunciation game originated by WOAW which is described in the following account:

Many times listeners have occasion to criticise announcers on their pronounciation of certain names of compositions, artists, towns and composers. Many of these suggestions are well taken by announcers who benefit from constructive criticism. On the other hand, there are occasions when pronunciation is regionally relative, and, as regards proper names, it is almost impossible to have a definite rule. Frequently the names of compositions are in a foreign language, and Americanisms are as popular as. the foreign pronunciation. But there is a great variation on this particular point.

WOAW is interested in maintaining the high standard of announcing, and, as a means of interesting the listeners as well as stimulating the announcer to the nearest perfect pronunciation on all occasions, a novelty contest has been arranged in which the listeners pointing out the mistakes of the announcer on certain programs will be rewarded with a gift. The contest, was given its first tryout on May 20, between 9 and 10 P.M.

In order to determine the first listener to make correction of an error, the listeners telegraphed their correction so that the time registered upon the telegrams determined the first correction. In order to assure the listener that the program was not memorized in advance, the announcer made at least five errors on each program of the contest.

Prizes will be awarded only for the first 10 errors made by the announcer. The pronunciation of all words, not including proper names, is determined by the Funk & Wagnalls' Unabridged Dictionary.

Broadcast Miscellany

NO ONE has asked us to select the Best Radio Speech of the year. And had a delegation of listeners, accompanied by a brass band, appeared at our "Listening-In Studio" a week ago with such a request we should have been sorely perplexed and unable to answer. Certainly we should have found it easier to suggest a Worst Radio Speech, as a myriad such would immediately come to mind clamoring for the honor. But now we are not only willing but anxious to constitute ourself judge and jury empowered to select the year's best speech, for we have heard it.

Thomas A. Edison, perhaps the greatest man living in this current manifestation of Civilization, made said speech. The occasion was the convention of the National Electric Light Association at Atlantic City, the proceedings of which were broadcast by WEAF and company. Mr. Edison was introduced by the chairman amid the thunderous applause of the delegates who paid just tribute to him.

Mr. Edison's speech was as follows:

"This is the first time I ever spoke in a radio. Good night."

AN INSTANCE in which radio performed a service of genuine musical importance was the broadcasting by WGBS of Gluck's opera "Orpheus" from the Provincetown Playhouse, New York. "Orpheus" is one of the group of venerable musical dramas whose revival is continuously and piteously urged by a very small wing of the opera going public, and which are never revived for the good reason that they would not fill ten rows in the average opera house.

"Orpheus" was first produced at the Hofburg Theatre in Vienna on October 5th, 1762. The first record of a performance in America is at the Winter Garden (also called Tripler Hall) on May 25th, 1863. Since 1910 when it was sung at the Metropolitan Opera House, the music of "Orpheus" has been heard only in a single concert performance, presented by the Society of the Friends of Music, Arthur Bodanzky conducting.

The opera was revived by the Provincetown Players as its last subscription offering of the season and was well received by New York critics. And we trust it was heard by at least some of the Gluck and Mozart devotees.

PERHAPS it is because we are not used to dealing with large figures, perhaps it is because we consider three letters in one delivery a rather large sheaf of mail, at any rate we are generally skeptical of the statistics eternally emanating from radio station publicity departments relating to the fabulous numbers of applause letters received. Never do we receive a photograph labeled "Six Foot Stack of Telegrams Received on KKK's Third Birthday" without scrutinizing it carefully to discover old soap boxes and other padding in the center of the pile. But if ever we wanted to believe implicitly in the exactness of the count it is in connection with the 1553 letters mentioned in the following item:

When the new broadcasting schedule of Westinghouse Station KYW was put into effect on Monday, April 19, the studio gang wondered how many youngsters would be listening-in on Uncle Bob the first night, because the time was changed from seven o'clock to six o'clock with no previous announcement.

On the first evening of this time, Uncle Bob promised to write a personal letter to each of the children who were then listening and who would write to him about it. Uncle Bob thought only a few would be received, but on three days following, he got 1553 letters. He is now writing answers, morning noon and night and still has many hundreds to go before the job is done.

SELMA LAGERLÖF

One of the greatest of Swedish writers, before a microphone in her own country. Her latest book, *Treasure*, has recently been published

Uncle Bob being one of the pernicious tribe of bed time story tellers who refer to their listener's as "kiddies," we hope he gets dislocation of the jaw licking the 1553 stamps.

DINNER music at the Hotel Traymore in Atlantic City is now shared by radio audiences via WPG. This is one of the best of hotel orchestras. Its personnel is Alex Hill, director and violinist; Allen Feldman, second violin; V. Vladimir Coonley, viola; Jean Kayaloff 'cellist and Nicolas Stember, pianist.

IT IS high time we made some mention in these columns of "Sam 'n' Henry." "Sam 'n' Henry" is a WGN institution and has been running every night since about as far back as we can remember. It is a sort of radio adaptation of the comic strip—and just about as comic. Sam and Henry are two colored boys who came up to Chicago, from where we have forgotten, and proceeded to get themselves in a series of jams of more or less humorous nature. They evidently have an enormous audience; every soul we know has at some time or other asked us, "When are you going to write up Sam and Henry?" This very faithful audience is treated every night at 10 P.M. to ten minutes of eavesdropping on the colored boys' affairs.

Sam—or is it Henry?—has a very deep bass voice, and the other a thin piping one. They engage in drawling conversation with frequent repitition of stock gag lines. To give them due credit, their characterization in excellent. Their patter—on the few occasions that we have listened to them—has seemed to us exceedingly dull. But don't let that scare you off, as we have been assured, by persons to whose good taste we humbly acquiesce, that if they are listened to with some regularity their daily adventures attain an enthralling interest and listening to their 10 to 10:10 program becomes an unbreakable habit.

FROM certain publicity material furnished by WHAZ:

The tendency toward the combination of education and public service as the highest ideal in radio broadcasting is seen in the plan recently inaugurated by the WHAZ station at Rensselaer Polytechnic Institute to devote a certain number of evenings each year to broadcasts under the auspices of the Troy Chamber of Commerce, in which civic features and entertainment representative of the talent of the city are presented. The second of these programs will be presented next Monday evening about 10 o'clock, Eastern Standard time, an hour calculated as best for hearing through the larger part of the country.

And so—the dissemination of information concerning the attractions of Troy, New York, is the highest ideal in radio broadcasting! Hurray!

THOUGH at the time we write the series has not yet commenced, we are given cause to rejoice in the announcement by Charles B. Popenoe, manager of WJZ, that the radio audience will have the opportunity of listening to the Stadium Concerts of the New York Philharmonic Orchestra twice weekly during the summer months.

The opening concert was to be given on Wednesday night, July 7. The series will continue throughout the summer until September 1 with WJZ broadcasting the Wednesday night programs and both WJZ and WRC broadcasting Saturday nights. As in the last few years, the New York Philharmonic Orchestra will play at all the Stadium Concerts.

Established in 1842, the New York Philharmonic Orchestra is now in its eighty-fifth season and has, by virtue of its most excellent ability, won the place of prominence in American musical circles. Both the Winter Series and the Stadium Concerts during the summer months attract the most exacting of audiences and it is indeed a great privilege that the radio audience is to be allowed the entree to these musical treats.

The Chief Conductor for the season will be Willem Van Hoogstraten, who has led the Stadium Concerts for the last four years. The guest conductors will be Nikolai Sokoloff, of the Cleveland Orchestra; Henry Hadley, associate conductor of the Philharmonic Orchestra; and Frederick Stock, conductor of the Chicago Symphony Orchestra. Messrs. Sokoloff and Hadley are already well known to the radio and Stadium audiences; but Mr. Stock's appearances will be his first in the New York summer season.

Mr. Van Hoogstraten was to open the season on July 7th and will conduct until July 28th, when Mr. Sokoloff will appear until August 3rd. Henry Hadley will lead the concerts from August 4th until August 10th, with Mr. Van Hoogstraten reappearing for the week of August 11th. Mr. Stock is to conduct during the week of August 18th, and Mr. Van Hoogstraten will conduct the concerts of the final week, beginning August 25th.

As an added feature of the broadcast Stadium concerts this year, the radio audience is to be allowed to select the compositions to be rendered by the Philharmonic in the last radio concert of the season. As the season nears its close, the radio listeners are requested to send in the names of the selections which they consider would make an ideal farewell concert or a selection which they have particularly enjoyed, and from these selections of the radio audience, the program of the final concert will be compiled.

THE STATION HOUSE AND MASTS OF CNRA

The Moncton, New Brunswick, station of the Canadian National Railways' chain of ten broadcasting stations. Most of these broadcasters are heard as well and as generally in this country as in Canada. The masts at CNRA are 150 feet high and the towers are spaced 200 feet apart

PERHAPS we have already given enough publicity in this department to the Atwater Kent Hour. But we're going to hazard a little more. For, after all, the Atwater Kent Hour is in the business for the publicity, and hence, conversely: publicity is what keeps it in the business and we want it kept in the business of supplying what is indisputably the best of radio's regular weekly features. And so, for the benefit of the few who may not have heard the program, we here record the impressive line-up of stars in the final concert of the 1925–1926 winter series.

Josef Hofmann and John Powell, pianists, Francis Alda and Maria Kurenko, sopranos, Albert Spalding, violinist, Louise Homer and Katherine Meisle, contraltos, and Allen McQuhae, tenor, each of whom had been heard earlier in the series, were assembled in a joint concert of an hour and a half duration.

The summer Atwater Kent series is now in progress, differing in that the concerts last but a half hour and are lighter in type. They are under the direction of Allen McQuhae. The regular 1926–1927 series will start some time in October.

AND further good news concerning summer programs is the announcement by WEAF that arrangements have been completed for the broadcasting of the popular Goldman band concerts. The first concert was held on June 14. They are broadcast direct from New York University and from The Mall, Central Park.

How to Rate the Power of Radio Stations

Details of International Practise—Power Relations in Wire Telephone Lines—The Avalon-Deer Park Circuit—Operating Public Address Systems—A Law Against Fading—Comment of Interest to the Public and Broadcaster Alike

"AS THE BROADCASTER SEES IT"

By CARL DREHER

Drawings by Stuart Hay

BEFORE broadcasting appeared to amuse and vex the world, radio engineers were concerned with the power of wireless telegraph transmitters. These, in 1916 and thereabouts, were mainly of the spark type, consisting essentially of a motor generator feeding 500-cycle alternating current to a high tension transformer, which charged a condenser in connection with a suitable spark gap and oscillating circuit, and so ultimately produced damped high frequency oscillations in a radiating antenna. Such sets, in America, were rated in terms of energy input to the primary of the step-up transformer. The most popular size of set for ship-to-shore work was rated at 2 kilowatts on this basis. Possibly 15 per cent. of this energy got to the antenna, which therefore received something in the neighborhood of 300 watts of radio frequency power. The set designers of that day preferred to talk about input to the transformer, for one reason which was obvious—the greater ease of measuring power at a commercial frequency and low voltage, and for another reason which their self-esteem probably did not allow into the upper stories of their consciousness very often—the fact that 2000 watts sounded more impressive than 300, and did not illuminate the miserable over-all efficiency of the transmitter too unsparingly.

The Germans, however, with that tactless thoroughness which has given rise to various emotions in other peoples, were already rating their radio transmitters in terms of radio-frequency power in the antenna—"Turm-Kraft," as they called it, which, literally translated, means "Tower-Power." When a German said he had a 250-watt radio set, he meant that it could put that much energy into a suitable antenna. In the United States, when radio telephony came into its own, we adopted this basis of grading transmitters. Practice in this regard is not uniform all over the world, however.

This is pointed out by Capt. P. P. Eckersley, Chief Engineer of the British Broadcasting Company, in an article on "Power: a Vexed Question," in the *Radio Supplement* (London) for March 5th. Eckersley gives the following table for a "Standard $1\frac{1}{2}$ Kilowatt Set":

Point of Measurement	*Power*	*Used by*
Total high tension input to set from transformers	6 kw.	Some Continental organizations.
Power to anodes of oscillating valves	1.5	British and all members of the Geneva Bureau for comparison purposes.
Power to aerial	1.0	American and some Continental.
Meter-amperes	300	Governments and scientific bodies

When Eckersley speaks of a "standard" $1\frac{1}{2}$-kw. set, he means the British standard, of course. The British rate their sets on the basis of power delivered to the plates of the oscillators. As tubes now go, their efficiency in converting high tension direct current into radio frequency oscillating energy is about 60 per cent. Thus the power delivered by the oscillators to the antenna is about $\frac{2}{3}$ of that received by the plates, or working in the other direction, if we multiply the output of the oscillators by $1\frac{1}{2}$ we get the high tension input. It follows that to convert the power of an American station to the British standard, we must multiply by a factor of 1.5, while if we wish to rate British

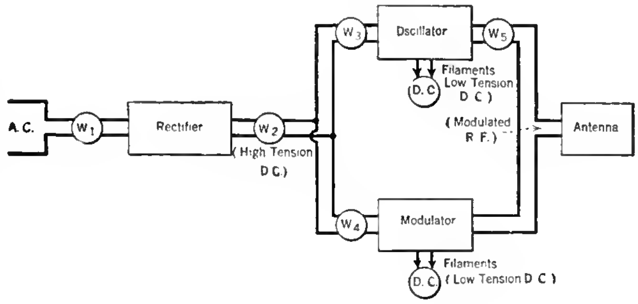


FIG. 1

stations according to American practice we must multiply the nominal power by 0.66.

To me the American-German method of expressing power seems more logical. The output is what counts. The ultimate output (*radiated* energy) is very difficult to ascertain, thus we are unable to follow the really scientific procedure of expressing the power of the station in terms of that quantity. The next best thing is to work in terms of radio-frequency power in the antenna. The antenna current may be measured with reasonable accuracy, and the resistance of the antenna at a given frequency is likewise determinable. The power equals the square of the current multiplied by the resistance—a law not confined to antennas. If telephone stations are to be rated by power at all, the antenna power seems the most rational figure to be chosen. If we are to stop at any point ahead of the antenna, the total input to the rectifiers is just as pertinent as the high tension input to the oscillators, and will please the press agent of the station much more. In the above table, the 6 kw. rating is just as defensible as the 1.5 kw. rating, and perhaps more so, for there is some warrant for expressing the power of a machine in terms of the total input, when the output is in a form not readily measured. For example, we talk about a 0.5-kw. electric heater or flat-iron, this being the power absorbed by the heating element. In such cases, the power consumption, which determines the operating expense, as well as the effect on the supply circuits, is the chief quantity of interest to the user.

To show how the power varies, we may analyse the actual conditions in one modern station at an arbitrary power level chosen for illustration only, and considerably below the full power and rating of the station. Fig. 1 will aid the reader in following the energy transformations involved. We start with the rectifier, which consists of 12 tubes fed from an a. c. source, suitable alternating voltages being applied to plates and filaments. The first wattmeter, W1, reads 135 kw. The output of the rectifier is about 11 amperes d. c. at 9300 volts, corresponding to 102 kw. on the d.c. side. This high tension power is split equally between the oscillator and modulator frames of the set. Thus, W2 being 102 kw., W3 and W4 will each equal 51 kw. As W3 is the plate input of the oscillators, the British rating of the set at this level would be 51 kw. Assuming 66 per cent. efficiency, the oscillators deliver 33.6 kw. of radio-frequency energy (W5). This would be the American power rating of the transmitter for the illustrative output power we have chosen.

Another factor, however, must be taken into account. The oscillators and modulators require filament current, which in this case is in the form of d.c. Each tube takes 45 amperes at 15 volts, or 0.675 kw. If eight oscillators and 12 modulators are used, the former absorb 5.4 kw. and the latter 8.1 kw. for filament heating alone.

The total power consumption of the set is 135 kw., a.c. and 13.5 kw., d.c., adding up to a total of 148.5 kw. The mean r. f. power delivered to the antenna is 33 kw., an approximate power efficiency, overall and for this particular adjustment, of 20 per cent. Of course we must take into account, in comparing this figure with efficiencies of other machines, that we require at least as much energy to modulate the carrier as to produce it in the first place (Technical Operation of Broadcasting Stations. 7. *Modulation*. July, 1926. RADIO BROADCAST). Another element which prevents the over-all efficiency of even the best modern radio transmitters from attaining a more respectable level is the fact that several units must function in tandem, owing to the peculiar nature of the machine as a whole. The rectifier has an efficiency of about 75 per cent., and the oscillator of 65 per cent., which are middling good performances in the field of energy transformation. Taken together, however, they drop somewhat below 50 per cent. Then when we add the burden of filament heating, and the large energy consumption of the modulator, we ruin the efficiency of the transmitter considered as simply an energy transformer. But to consider it in this way alone is meaningless. It is as much as to say that a beautiful and healthy woman is useless because she is a poor piano mover. We rate such a woman by her physical beauty; we rate a modern radio telephone transmitter by its acoustic beauty, i. e. fidelity of reproduction. Efficiency in the narrow sense is allowed to go hang, very properly.

However, as energy is sacrificed apparently so recklessly in the best broadcasting stations, that is the more reason for not rating them at any intermediate stage, when the question of range and power is being considered. If power ratings in radio are to be made uniform internationally, therefore, the radio-frequency power delivered to the antenna would seem to be the most valid basis of comparison.

Those readers who are interested in the meter-amperes product as an expression of the effective range of stations, are referred to the article in this department on "Computing How Far a Radio Station Can Be Heard," in the June, 1925, Radio Broadcast. This factor takes the radiating qualities of the antenna into account, and is hence a step in advance of power ratings in terms of mere watts. Even then, however, we must consider percentage modulation, as Captain Eckersley points out, and as yet no one has worked out a rigid formula including this variable. Practically, as probably most stations run their modulation around 80 per cent. peaks, this factor cancels out in many instances, leaving meter-amperes or watts in the antenna as a valid basis of comparison between transmitters the frequency of which does not differ too widely.

Abstracts of Technical Articles

BEGINNING with this issue, there will be included in this department abstracts on acoustics, telephony, public address systems, broadcasting, and related subjects, where these papers have appeared in periodicals not readily accessible to some broadcasters. A few words are in order as to the purpose and limitations of these abstracts. An abstract is not a substitute for the original article. The abstract is an outline of the contents of a paper, no more. If it appears from this outline that the original paper is of value to a reader, the best thing he can do, whenever possible, is to get a copy of the complete paper and keep it in his technical library. A very useful collection of technical data can be built up from such small beginnings, and at a trifling cost compared to its value. We have no desire to interfere, however slightly, with the circulation of such invaluable media as the journals of the American Institute of Electrical Engineers and the Institute of Radio Engineers; on the contrary, we continually urge all technical broadcasters to join these organizations and to obtain their publications and reports with the other benefits of membership. In accordance with this policy, our general practice here will be to abstract papers a few years old, whose contents might otherwise be lost as far as the average broadcaster is concerned, where the material remains pertinent and valuable. Recent papers will be abstracted only under exceptional circumstances.

Abstract of "Applications of Long Distance Telephony on the Pacific Coast," by H. W. Hitchcock. *Journal of the American Institute of Electrical Engineers*, Vol. XLII, No. 12, December, 1923.

Wire telephony is almost as important to the broadcaster as the radio portion of his activities, and a partial outline of the above paper is presented because it contains a valuable description of one very variegated long distance toll telephone circuit, and the power relations existing therein.

The circuit in question runs approximately north and south through California, Oregon, and Washington as one of the "backbone routes" in this region. The diagram (Fig. 2) shows the various repeater stations between the terminals (Avalon, California, and Deer Park, Washington), the distances, type of line and method of transmission (cable—submarine, underground, or aërial; open wire; with voice and carrier frequency transmission) and the power levels along the entire circuit. The latter data are of most interest to the broadcaster, since he can compare the power levels along the wire circuit with the power levels in his own equipment. The fundamental difference, of course, is that the wire telephone people do their amplifying in moderate increments at convenient distances along the line, while in radio (excluding possible radio relay systems) we have no choice but to amplify on a grand scale at the beginning and end of the circuit only, with nothing but attenuation in between.

The speech is assumed to originate at Avalon, on Catalina Island. The transmitter there delivers about 1000 microwatts of speech energy to the line, which starts with a submarine cable to San Pedro on the mainland, followed by a stretch of aërial and underground cable, loaded. At Los Angeles this straight audio system changes to a 25-kilocycle carrier current transmission over No. 12 gauge open wire, which takes it up to San Francisco, where there are again some submarine and underground sections crossing the bay and in the city. On the return to Oakland the carrier frequency becomes 10 kilocycles over No. 8 wire, which is sustained all the way to Portland, where the carrier is discarded and the speech travels the rest of the route at audio frequency over a phantom and open wire circuit.

There are voice-frequency line repeaters at San Pedro and Walla Walla. Seven carrier-frequency amplifier stations are shown. There are also voice-frequency cord circuit repeaters at Los Angeles where the change is made from the toll cable to the 25-kc. carrier system, at San Francisco, to join the 25-kc. to the 10-kc. carrier circuits, and at Portland, where the transition to audio frequency is again made. In all there are some 15 repeaters on the stretch of 1622 physical miles. These repeaters keep the power between a maximum of 1000 microwatts and a minimum somewhat below 1 microwatt. Through this agency the over-all equivalent of this telephone circuit, running north and south practically the length of the United States, is reduced to 25 telephone miles, 4 microwatts being delivered to the instrument at Deer Park.

AVALON-DEER PARK CIRCUIT DIAGRAM

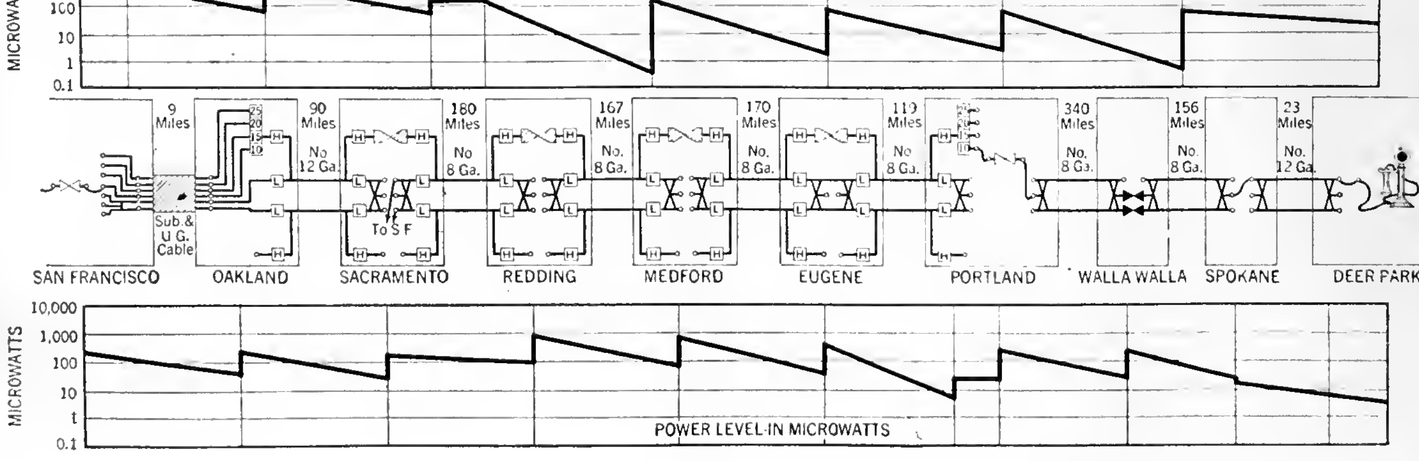


FIG. 2

That is, by means of the vacuum tube amplifier, a telephone circuit covering 1600 miles of territory is reduced, electrically to a standard transmitter and receiver connected by a 25-mile stretch of standard cable, and one can talk with the same ease over the one as the other.

Hitchcock's comments on the power relations are illuminating and are quoted in full:

Consider the conditions at a time when the power delivered to the line in question by the Avalon telephone is 1000 microwatts. The over-all circuit efficiency is about 0.4 per cent. (25 mile equivalent) so that four microwatts are delivered to the Deer Park instrument. Were the cord circuit repeaters omitted, the power transmitted would be reduced to 0.02 microwatts. Should all the repeaters, including those in the carrier systems, be omitted, the received power would be 1.3 x 10-16 microwatts.

Not only is it necessary to maintain a certain over-all efficiency, but it is also required that the power be kept within certain upper and lower limits at all points along the way. Should the voice currents become too great, overloading of the repeater tubes accompanied by distortion of the speech waves will occur. If the current becomes too weak, the circuit will be noisy or experience excessive crosstalk from other lines. These upper and lower limits make it necessary to amplify the current at regular and fairly frequent intervals as is done in the circuit shown. Were all the amplification to be effected at the receiving end, the noise and crosstalk would completely drown out the speech current. In case the amplification were all applied at the sending end, the speech input power would have to be about thirty billion kilowatts. Such a mode of operation is of course impossible.

Technical Operation of Broadcasting Stations

8. Public Address Systems

A CERTAIN municipality which undertook the job of running a broadcasting station placed on its civil service list, in addition to a broadcast engineer and operators, two public address operators. This was not illogical. The two jobs have much in common. In fact, right up to the radio frequency circuits, a public address system, with the horns omitted, is scarcely distinguishable from a broadcasting station. They diverge at the point where the one set of audio amplifiers modulates a carrier and the other set is turned onto a battery of loud speakers to convert their energy back into acoustic form. Both systems start with a high quality microphone. Their acoustic and pick-up problems are similar. And, when the two are used simultaneously in the same place or neighborhood, interactions may occur which must be taken into account. Broadcasters, therefore, should know something about public address systems, how to connect them with their own equipment, and how to avoid deleterious effects from them in other instances.

The usual public address system consists of microphones, generally of the carbon type and identical with those used in broadcasting, a "speech input" amplifier of about three stages, and a power amplifier which comes in several sizes, and feeds the projectors or loud speaker units. The "High Power Amplifier" size will deliver as much as 40 watts of electrical speech energy, which, assuming one per cent. efficiency in the loud speakers, may be converted into 4 watts of acoustic energy, or about four times the maximum sound emission of a hundred-man symphony orchestra. Or, to use the comparison of Green and Maxfield, whose complete paper on the public address art will be abstracted in a later issue, this 40-watt-output machine will feed all the twelve million telephone receivers in the Bell system at a level slightly above that usually considered commercial. This prodigious volume of energy—prodigious by acoustic standards, where, owing to the sensitiveness of the human ear, a little energy goes a long way—is required only for the largest audiences, particularly outdoors. For ordinary purposes, a "Medium Power Amplifier" with about one-tenth the output, or four watts electrical voice frequency energy, is provided. These power amplifiers generally use a push-pull arrangement of power tubes, two being provided for the medium power size and four (two in parallel on each side of the push-pull circuit) for the high power or 40-watt size. The tubes used in such amplifiers, if oscillating at radio frequency, would be rated at outputs of the order of 50 and 250 watts, and the plate voltages for public address work range up to about 1000 volts.

The speech input amplifier which precedes the power stage runs on 350 volts or lower, and its maximum output, under half a watt, is suitable either for feeding the power stage or for transfer to a line. Thus, if it is desired to feed a broadcasting station or chain from a public address system, the proper point at which to tap off is the output of this first amplifier. If connected to a line, the amplifier must be terminated in a suitable step-down transformer, according to the usual method of matching impedances, in a ratio of about 5000 ohms on the amplifier side to about 250 on the line side.

For a medium size hall of the order of sixty by forty by twenty feet, adequate public address service may be provided with one stage of power amplification following an ordinary field amplifier used in broadcasting. Such an amplifier is similar to the "Speech Input Amplifier" partially described above, with a maximum voltage amplification of the order of 3000, a "gain," in telephone terminology, of 75 miles. This is fed from the usual 373-W carbon transmitter. The power stage may consist of a single tube, 7.5 watts oscillator rating, with 400 volts on the plate, the tube being biased to draw a plate current of 25 milliampers at this voltage, and feeding a cone loud speaker through a suitable transformer (probably 1:1) to keep the d. c. out of the loud speaker windings.

The main difficulty to be guarded against in operation of loud speaking systems is acoustic coupling between the projectors and the microphone. This acoustic feed-back results in audio-frequency howling, if the coupling is close enough, or in distortion and loss of high frequency components at points below this. The usual solution of the problem is to mount the loud speakers so that the sound they emit will not reach the microphone in any great degree. This is usually accomplished by placing the horns or cones well above the microphone position, and slightly in front, so that the microphone lies somewhat in the lee of the loud speaker emission.

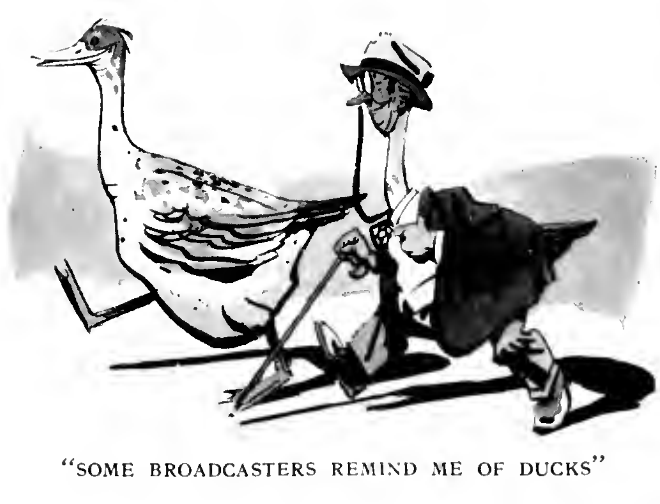
Frequently, in the business of broadcasting banquets and other functions, a broadcast and public address pick-up work side by side and independently. In such cases the broadcaster wants to pick up as little of the public address acoustic output as possible, because it stands to reason that the quality of the latter will not be as good as the speech input to the microphones. Furthermore, if the public address system is in a singing condition, or on the verge thereof, its output will interfere with or distort the input to the broadcast microphones. In self-protection the operators of the public address system must shield their own input from the projectors, and, as the two sets of microphones are normally side by side, the broadcaster is protected at the same time. In practice, however, a preliminary test of both systems in simultaneous operation is by no means to be neglected.

A broadcasting station may also interfere with a nearby public address installation by sending radio frequency into the latter. If rectified in the amplifiers, this pick-up may end up as audio frequency in sufficient quantity to be audible in the projectors. The remedy is to provide radio frequency traps at a few strategic points. This measure will be discussed in a later issue in an article on the general topic of protection against extraneous radio frequency pick-up, which is sometimes quite serious in large cities where many broadcasting stations are crowded together.

Ducks and Broadcasters

IF YOU observe the expression of a live duck, you will note that he looks exceedingly alert and stupid at the same time. This complication arises from the fact that the duck's characteristics fall into two divisions. Under the first he seeks food. When in the water his search is necessarily aqueous. When on land, the duck stretches his serpentine neck in all directions with short, jerky movements, and his beak quivers expectantly. He hopes he may catch a fly. In this endeavor all his energies are engaged, and hence the fowl looks alert. The other qualities of the duck's character, are found to be of a low order. Hence, aside from the limited vivacity which he exhibits in his search for nourishment, the duck looks stupid. In short, he is only a duck.

I do not wish to insult the profession which I grace in company with other precious jewels, but some broadcasters and hangers-on of broadcasting remind me of ducks. They exhibit the same jerky activity and a considerable degree of adaptability in one direction; the rest is silence, if one wishes to be charitable. They vibrate from one thing to another, giving the impression of remarkable briskness, but in a short time you discover that they really have no idea of what they are doing. There is no coherence to their movements; they simply jump around. They know a little about a number of things, but they know nothing thoroughly, and at bottom they are simply stupid. They are noisy and restless,



"SOME BROADCASTERS REMIND ME OF DUCKS"

This gives them the same restricted expression of alertness which we see on the duck, and for the rest they look like half-wits, which they are. Heaven send the day when some hard working and sensible broadcaster, tried beyond endurance, will throw one of them downstairs and scare the rest out of the studios.

Radio Takes Us Back to Nature

A WHILE ago Professor Morecroft ironically suggested that the Government undertake an investigation to determine the causes of poor radio reception last winter, with a view to preventing a recurrence of the atmospheric phenomena which prostrated so many DX fiends. A law would in due course be promulgated, forbidding the sun to break out in spots every eleven years and thus giving the earth's magnetic field the D. T.'s and raising hob with the propagation of the precious broadcasting waves. About everything else has been regulated, so why not the atmosphere and the celestial bodies?

Why not, indeed? The regulation would not work, to be sure, but it might give some body of regulators comfort, not to speak of a possible income. There are plenty of precedents. Everybody knows that nature cannot be regulated, that we can only follow her laws, which are immutable, although our understanding of those laws is by no means immutable. Yet we constantly act as if Nature could be chucked under the chin and cajoled into giving us what we want.

Radio may have some effect in curing us of this illusion. By "us" I mean the general public, excluding engineers and scientists, who must come to terms with Nature early in their careers, if they are to hold their jobs. But, some one will say, how can radio bring us back to Nature? Is not radio a highly artificial thing, the last of a series of mechanistic developments? It is, but it is nevertheless profoundly natural. In the last analysis everything is natural. It does not matter whether it is a nasturtium seed just pushing its green stem out of the earth, or a revolving piece of iron with wire wound around it. Furthermore, radio is unique among machines, in that it consists of two mechanisms separated by a natural medium. It therefore includes a cross section of both kinds of natural behavior, that of the machine and that of the atmosphere and the forces of space. At present we have more control (i. e., we know better how to conform to the natural laws) of the machine. We have considerable control over what we broadcast and what we receive—after we receive it—but between the two the carrier and its side bands frequently get a terrific mauling, and as yet our brand of law and order has not been introduced into the reaches of space through which the waves must travel.

What will be the effect of all this on the average citizen with his radio set? On some the effect will be nil. They want to get music or baseball scores out of their sets; if anything interferes with that reasonable purpose they swear, turn off the filaments, and go to the movies. But other BCL's are of a more inquiring disposition. They want to know why stations fade, why the quality of reproduction is not as good from a station two thousand miles away as from the local two miles away, why the six UV-201A's went up the flue when the B-battery lead touched the filament rheostat. Such questions are rather a novelty. For once the man participates in the machine life around him, instead of leaving the running of it to specialists. Take the city dweller, for example. He is out of touch with the life of the country, which he sees about two weeks each year. He utilizes the conveniences of city life around him, without wondering about it, letting it stir his imagination, or trying to find out how it works. Does the traveler in the subway think about the oil circuit breakers and the rotary converters in the sub-stations? Does he consider how his food reaches him, and in how many days he would starve if the distribution system cracked? Does he read a book about his machine switching telephone? Probably he does none of these things. There is something curiously numbing about modern life. Everything is done for one, for money, down to one's very amusements. Radio in its early stages is a step in the opposite, and, I think, healthy direction. The passive recipient becomes a participant. Of course, when radio is perfected, perhaps he will become passive again, and radio sets will be exactly like vacuum cleaners or fountain pens. That day is not yet on us. That radio can be divested of all romance and uncertainty also seems doubtful. Rather it seems to me that it partakes of the nature of travel, which always contains something potentially exhilarating and uncertain.

"A LAW WOULD BE PROMULGATED, FORBIDDING THE SUN TO BREAK OUT IN SPOTS"

These elements in radio are valuable in two ways: as a mental discipline and as something which tends to heighten interest in life. The second has been outlined above. The first is equally important. It has been pointed out by many observers ahead of their age, such as Bertrand Russell, that it is of the utmost importance that people should not harbor views for which there is no definite evidence. Actually, very few people think at all in the proper sense of the word. They merely employ a sort of association that passes for logic, in the endeavor to satisfy shifting emotional states. Only scientists, engineers, some lawyers, judges, writers, business men, and administrators really think professionally, and then only in their special fields, as a rule. This distrust of reason costs us dear. Since we have made the world so complicated, by introducing machinery and thereby greatly increasing its population, it is of the utmost importance that we learn to act more reasonably. The direct intellectual content of radio, as yet, is not high. But it has introduced a considerable body of people to the inside of the world which sustains them, in a form which they do not take for granted, like the weather or the 8.18 into town. Perhaps the effect will be beneficial. We must wait and see. If it does nothing more than to teach people what legislation can *not* do—to return to Professor Morecroft's satirical observation—it will be worth its upkeep on that score alone.

A Question of Phraseology

AMONG the British announcers the use of the form, "London calling," and similar phrases remains very common. To such an extent is broadcasting still dominated by its parent, radio telegraphy. Could anything be more inept? "Calling" whom, or what? Does one "call" the audience between arias at the opera, or between numbers at a song recital? If it is necessary to announce call letters or to give the origin of a radio concert, the simple mention of the letters, or the sentence "This is . . . ," or "You are listening to . . ." is surely more appropriate. In radio telegraphy, where one calls a specific station by the repetition of its designated signal, followed by one's signature, the use of the term "calling" has some sense. In broadcasting it is, at best, an unintelligent adaptation.

There are plenty of such fossils in the broadcasting art. In the United States, at least, at this writing, the law under which all radio activities, including broadcasting, are carried on, is some fourteen years old. It has little more valid applicability to broadcasting than a city ordinance prohibiting sweeping sidewalks after eight o'clock in the morning. The Secretary of Commerce has been able to carry on his administrative functions only by extending his authority, by common consent, beyond the patent limitations of the law. Under the circumstances, it can hardly be expected that the phraseology of radio broadcasting should not also show traces of a past epoch.

One broadcasting station boasts of a stronger "signal" than another in some locality. To "signal" is to communicate by signs or symbols. Direct transmission of speech and music is not signalling. Again the regression to the telegraph level. The announcer "signs off," and asks the radio audience to "stand by." Then there is the phrase, "broadcasting direct from—" used by field announcers. The "direct" is totally unnecessary. Originally the custom was to say, "by direct wire," when the use of telephone lines in connection with broadcasting stations was still a novelty, and the broadcasters could not refrain from boasting about their new achievement. They tried to emphasize that their wires did not run promiscuously all over town like the pairs rented by telephone subscribers for $3.50 a month, but proceeded virtuously and exclusively to the point of broadcasting. From such origins our radio phrases spring.

SOS Publicity

READERS of the article on the above topic in the May, 1926, issue will be interested in the following communication from the Commissioner of Navigation, Department of Commerce:

"The Bureau has your letter asking an expression of the opinion of this office on the subject of sos publicity.

"You are no doubt familiar with our radio laws and regulations and also the International Convention. The 19th regulation under Section 4 of the Act of August 13, 1912, provides a penalty for divulging or publishing the contents of a message which is addressed to someone. Radio distress messages are not usually addressed to anyone in particular though there are times when a vessel in distress does address some particular ship, but this is rather an exception than a rule. "Article 2 of the St. Petersburg Convention of 1875 which is made a part of the London Convention referred to in Article 17, provides that the high contracting parties bind themselves to take all the necessary measures for the purpose of insuring the secrecy of the correspondence and its safe transmission. No reference is made in either case to sos calls.

"Good reasons can probably be offered why the sos call should not be considered secret and equally good reasons can no doubt be offered why they should be considered secret.

"It is believed that you desired to have the argument against the secrecy of distress calls. Therefore one of the arguments advanced is furnished you which is as follows:

"It sometimes happens that a vessel sends out a distress call when the people on board are not in immediate or actual danger of loss of life. Publishing information that the vessel is in distress causes undue alarm and worry on the part of relatives ashore who have not an opportunity or do not know how they can get the correct information as to the seriousness of the accident or the extent of the danger.

"Taking the other side of it, if secrecy is carried too far, it might cause some inexperienced operator to withhold information which might be helpful in connection with saving the vessel."

D. B. CARSON
Commissioner of Navigation,
Department of Commerce.

Power and Code Interference

PROGRESSIVE ship-to-shore radio companies are rapidly discarding spark transmitters in favor of c.w. sets, principally of the tube type. But this takes time, and the immediate elimination of spark transmitters in the marine band is out of the question, hopeful radio critics notwithstanding. Hence it would be a good thing if the letter printed below could be put into the hands of every spark transmitter operator in the country. It is taken from *World Wide Wireless*, now the *Wireless Age*, the house organ of the Radio Corporation of America, and is addressed to Mr. J. B. Duffy, the superintendent of the Eastern Division of the Marine Department of that company.

"RADIO IS LIKE TRAVEL, ALWAYS CONTAINING SOMETHING EXHILARATING AND UNCERTAIN"

Below is a list of stations worked on extremely low power during this past voyage. I have been interested in determining the amount of power necessary to insure satisfactory communication, and am more than convinced that coastwise vessels fitted with spark are using too much power. The 600-wave on full 2 kw. is bound to overlap the broadcast waves, particularly when the vessel is ten or fifteen miles from shore. I have heard several complaints of spark still interfering with programs. Coastwise vessels, as you know, often go as close as ten miles to large cities, viz. Charleston, Jacksonville, etc., and their use of unnecessary power is bound to cause disturbance.

From the following achievement it becomes evident that the use of a fraction of the maximum power rating is all that is necessary.

May I ask you to have this list printed in *World Wide Wireless* in order that it may reach RCA operators, and cause them to cut down power when possible?

STATION WORKED	POWER	RADIATION	SIGNALS
WPA, Port Arthur, Tex.	0.25kw.	5 amps.	QSA
WSC, Tuckerton, N. J.	0.10	2	"
WIM, Chatham, Mass.	0.10	2	"
WSA, Easthampton, N. Y.	0.10	2	"

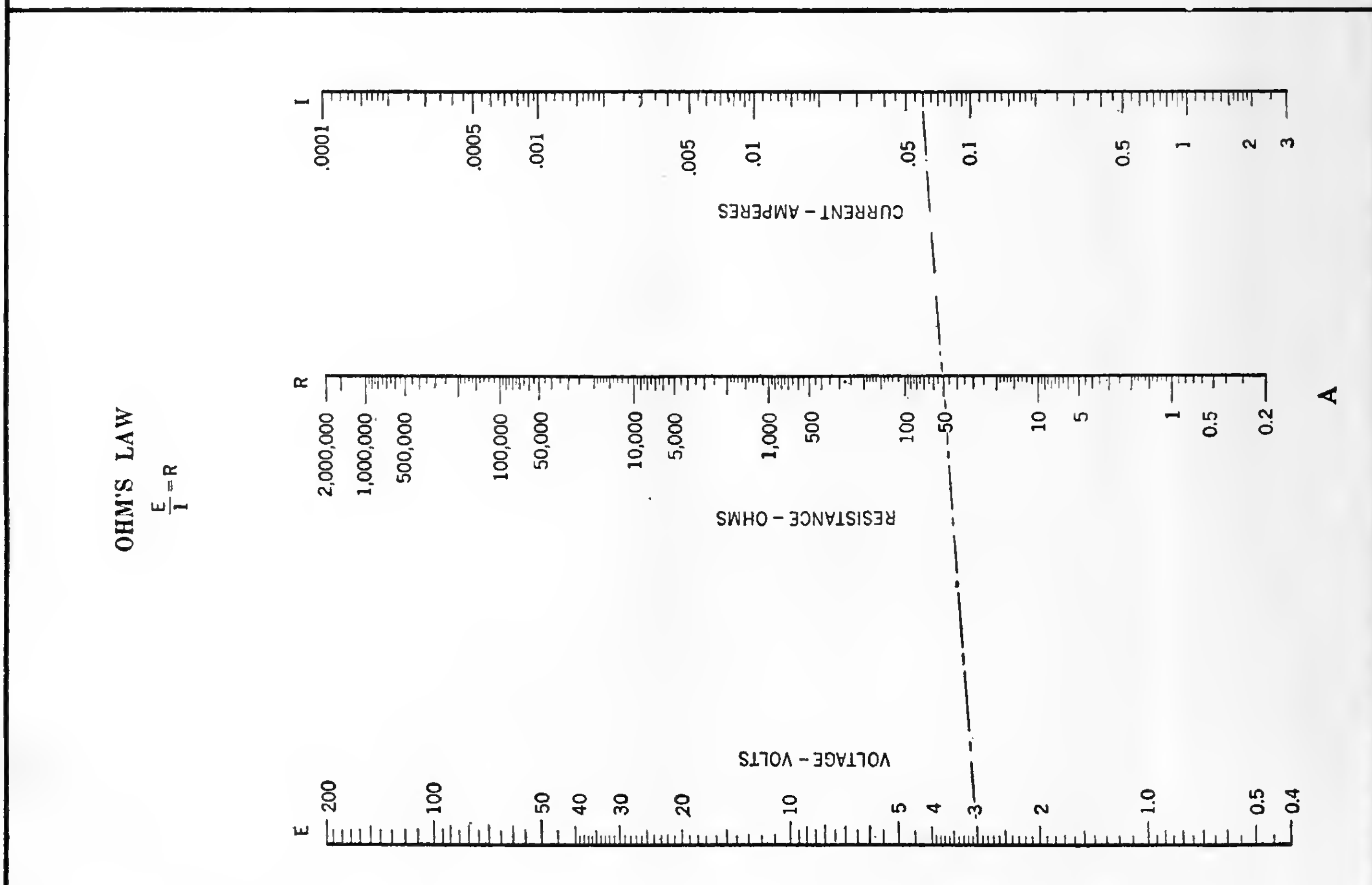
Time, about midnight. Our position about 30 miles south Hatteras.

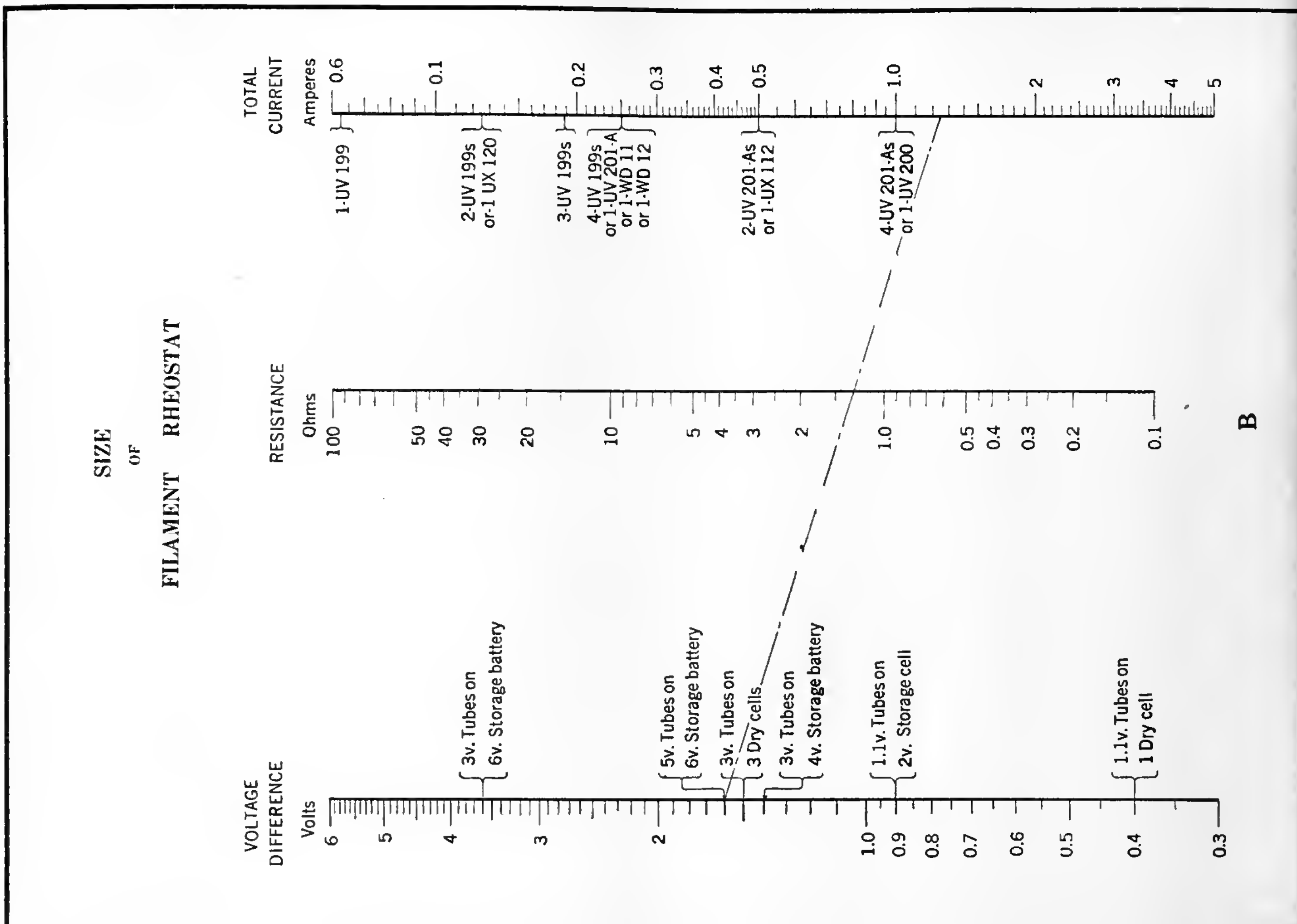
At ten o'clock in daylight, Savannah was worked about 200 miles on one-quarter kilowatt, two amperes in the aerial, and reported us loud. Transmitter, Marconi P-4.

H. L. CRANDALL.
Radio Operator, SS *City of Montgomery*.

The *City of Montgomery* was about 1100 miles distant from Port Arthur, Texas, which Mr. Crandall worked on one-quarter kilowatt, or about one-eighth of his available power; while the distances covered on one-tenth kilowatt, or one-twentieth of the available power, varied between 300 and 600 miles, roughly. This is admirable work with a spark set.

These figures should not be taken as proving that marine sets are excessive in power. It is one of the characteristics of radio transmission that the power required to communicate over a given distance varies enormously. The work done by this operator shows the small amount of energy required under favorable conditions. Under other conditions, the full 2 kw. might be none too high for ranges much less than those covered. Heavy static, an sos, and any number of other situations the radio man knows, may demand the full power available. (Incidentally, the use of minimum power required for reception also facilitates marine communication, and has been urged for years past on this basis alone.) The point is, however, that the output of sets is made variable in order to meet varying conditions effectively, and too many operators, through sheer indifference, run their transmitters full blast everywhere and always. To these muddlers the men on the *City of Montgomery* present a welcome contrast.


OHM'S LAW
E/I = R
E
VOLTAGE - VOLTS
R
RESISTANCE - OHMS
I
CURRENT - AMPERES
A


SIZE OF FILAMENT RHEOSTAT
VOLTAGE DIFFERENCE Volts
3v. Tubes on 6v. Storage battery
5v. Tubes on 6v. Storage battery
3v. Tubes on 3 Dry cells
3v. Tubes on 4v. Storage battery
1.1v. Tubes on 2v. Storage cell
1.1v. Tubes on 1 Dry cell
RESISTANCE Ohms
TOTAL CURRENT Amperes
1-UV 199
2-UV 199s or 1 UX 120
3-UV 199s
4-UV 199s or 1-UV 201-A or 1-WD 11 or 1-WD 12
2-UV 201-As or 1-UX 112
4-UV 201-As or 1-UV 200
B

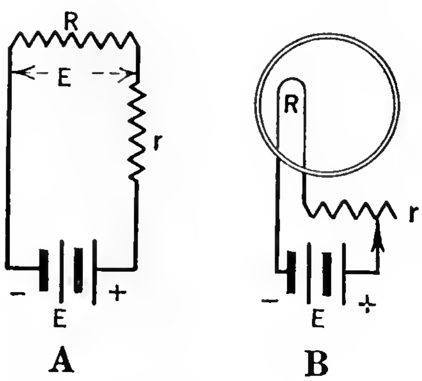
How Ohm's Law Can Help Every Radio Fan

A Simple Explanation of this Well-Known Electrical Formula—How it May Be Applied for Determining the Size of Rheostats or Voltage Drop Across a Resistance, Etc.—The Use of the Accompanying Tables

By HOMER S. DAVIS

ONE hundred years ago, George Ohm, a German physicist, found that an increase in the voltage applied to a conductor caused a directly proportional increase in the flow of current. Now known as Ohm's Law, this is one of the most important principles of electricity, and is expressed mathematically as $\frac{E}{I}=R$ where E stands for pressure, exerted by the battery or other energy source, in volts, I the current in amperes, and R the resistance in ohms. This rule applies to each separate portion of an electric circuit as well as to the circuit as a whole.

The home experimenter will find many uses for Ohm's Law; estimating rheostat sizes, battery drain through potentiometers or voltmeters, voltage drop across instruments in the plate circuit, etc., are some of the uses to which this law may be employed. To avoid the mathematical calculations involved in using it, the two alignment charts accompanying this article have been prepared; one applies to Ohm's Law itself, while the other is a special chart for determining the size of rheostat required for any combination of filament control. Of the three quantities, voltage, current, and resistance, two must be known in order to use the charts; the latter consist of three parallel scales of these quantities. Simply draw a straight line between the two known values; the point at which this line, extended if necessary, intersects the third scale, marks the value of the unknown. Working out two or three examples will better illustrate this procedure. To find the filament resistance of the UV-199 tube when lighted, draw a line, on chart A from the filament voltage, 3 volts, to the value of the current consumption, 0.06 amperes; this line crosses the middle scale at 50, the resistance in ohms. Again, suppose a 200-ohm potentiometer is connected across the filament leads of a receiver using 5-volt tubes. A line between 5 on the voltage scale and 200 on the resistance scale, when extended, will meet the current scale at 0.025, the drain in amperes on the A battery. To take still another case; a milliammeter in the plate circuit of one of the tubes of a resistance-coupled amplifier reads 0.3 ma., using a 100,000-ohm coupling resistor; the loss in plate voltage across the resistor may be found from the chart by drawing a line from 0.0003 amperes through 100,000 ohms until it intersects the voltage scale, indicating a drop of 30 volts. Other applications of this chart should suggest themselves to the experimenter.



$$r = \left(\frac{E}{I}\right) - \left(\frac{E_1}{I}\right)$$

Where r = Rheostat resistance
E = Battery voltage
E_1 = Filament terminal voltage
I = Filament amperes

Example:

$$r = \left(\frac{6}{.25}\right) - \left(\frac{5}{.25}\right) = 4 \text{ Ohms}$$

AN OHM'S LAW EXAMPLE

Without the aid of the charts, to find the resistance value of a unit as in r above, would involve the actual use of the formula with its attendant mathematical calculations. The battery voltage, the tube filament resistance and the filament current are usually known; from these values it is possible to calculate the unknown

TYPE	FILAMENT VOLTAGE	FILAMENT CURRENT IN AMPERES
112	5	0.5
199	3	0.06
120	3	0.125
200	5	1.0
201-A	5	0.25
11	1.1	0.25
12	1.1	0.25

While the last-mentioned chart can be used also for determining rheostat sizes, the second, chart B accompanying this article is better adapted to this purpose. The function of a rheostat being to take up the voltage difference between that supplied by the A battery and that required by the tube filament, the voltage scale of this chart is calibrated in terms of difference in voltage. The filament constants of the different types of receiving tubes in common use are shown in the accompanying table for reference.

The voltage of a single dry cell may be taken as 1.5, and that of a single wet or storage cell as about 2.2 volts when fully charged. A 6-volt storage battery contains three cells. The use of the chart is again best illustrated by working out a few typical examples. Suppose five 201-A tubes are to be controlled by one rheostat and operated from a 6-volt storage battery; the voltage difference is therefore 1.6 volts (6.6 minus 5) and the total current drawn by five tubes is 1.25 amperes (5 x 0.25). A straight line drawn between these two values on the chart intersects the resistance scale at 1.3 ohms. The nearest available commercial size above this should be chosen, such as a 2-ohm power rheostat, care being taken not to exceed the manufacturer's maximum current rating, in order to avoid overheating. Again, suppose that two UV-199 tubes operate from a six-volt storage battery on one rheostat; a line from 3.6 volts to 0.12 amperes crosses the resistance scale at about 29 ohms, indicating that a 30-ohm rheostat is the correct size. To take a third case; suppose it is desired to operate a 199 tube from the same rheostat with one or more 201-A tubes; this will necessitate a fixed resistance unit in series with the 199 to take up the difference of two volts. A line on the chart between 2 volts and 0.06 amperes indicates a resistance value of 32 ohms. Other cases may be worked out in the same manner.

EDITOR'S NOTE: *Mr. Davis assumes that in the use of the storage battery the voltage is 6.6. Where 5-volt tubes are used, the voltage difference would then be 1.6 volts as he states. In the article on filament control by J. B. Brennan in the April* RADIO BROADCAST, *the voltage of a fully charged storage battery on "no load" test was considered as 6.6 volts, but when a load was applied, the voltage rapidly fell to the usually accepted 6 volts. Where the reader assumes that his battery is 6 volts rather than 6.6, then the voltage difference is 1 volt instead of 1.6. However, this change will not alter the use of the filament rheostat chart, but it is mentioned to allay any doubt in the minds of users as to the correct rating of a storage battery and subsequent use of this value in the chart shown on page 324.*

NEW APPARATUS

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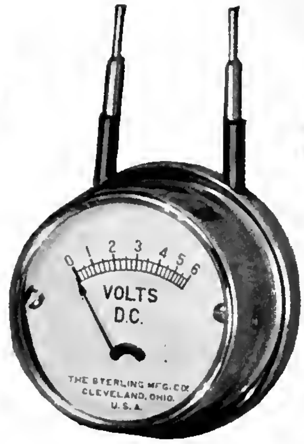

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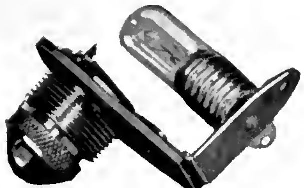

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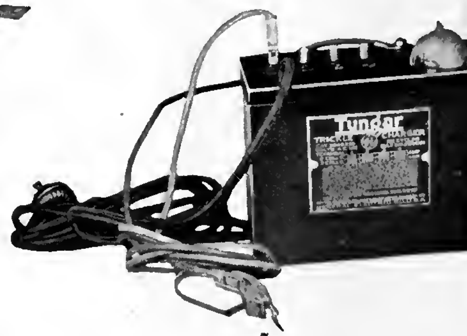

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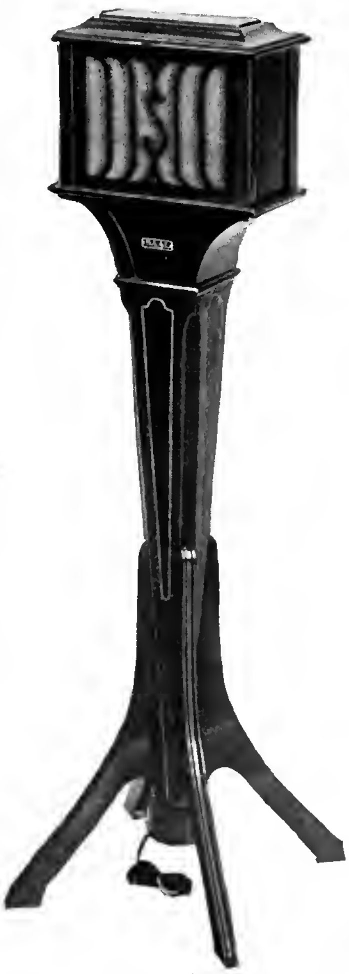

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No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
1.	Fixed Condenser, 2-mfd.	Mayolian Radio Corp., 1991 Broadway, New York City.	Filter circuit condenser in plate supply devices.	$ 1.50	A compact condenser unit made with high grade materials. Simple to include in home-constructed plate-supply units.
2.	D. C. Voltmeter, 0-6 Volts.	Sterling Mfg. Company, Cleveland, Ohio.	Measure filament terminal voltage.	$ 7.50	The voltmeter, which is fitted with pins, may be plugged into pin jacks to read tube filament voltages.
3.	Filament Switch and Pilot Light.	Bruno Radio Corporation, 222 Fulton St., New York City.	Indicates continuous circuit and also breaks circuit.	$ 0.75	By turning the knurled head which is fitted around the ruby window, the circuit may be "made" and "broken." A light situated behind the ruby window indicates when contact is made.
4.	Pedestal Loud Speaker.	H. C. Saal Company, 1800 Montrose Avenue, Chicago, Illinois.	Sound producer for use with receiving sets.	$38.00	A piece of furniture of pleasing appearance, the Saal Pedestal speaker makes use of an extra long sound chamber to produce good quality sounds.
5.	Filament Rheostat, Type 706.	H. B. Frost & Co., 314 W. Superior Street, Chicago, Illinois.	Control of filament voltage.	$ 0.50	Rigidly constructed and assembled in a metal frame. Positive contact over entire surface. Resistance 6 ohms. Current-carrying capacity 0.60 amperes. Other sizes procurable.
6.	Concertone Audio-Transformer.	Jefferson Elec. Mfg. Company, 501 S. Green St., Chicago, Illinois.	Transformer for amplification at audio frequencies.	$ 6.00	One of the newer types of audio transformers having large cores and large windings to insure good tone quality.
7.	Tungar Trickle Charger.	General Electric Company, Schenectady, New York.	For charging storage A batteries at various trickle charging rates.	$12.00	For use with 60-cycle a. c. line. Three charging rates, each for 2 sizes of A battery—small and compact. Employs tube for rectification.
8.	Browning-Drake Receiver.	Browning Drake Corp., 353 Washington St., Brighton, Massachusetts.	Broadcast reception.	$95.00	Employs five tubes, one r. f., one regenerative detector, and three stages of resistance-coupled audio frequency amplification. Excellent tone quality and covers entire broadcast band.
9.	"Orchestrion" Loud Speaker.	Radio Cabinet Company, 2123 Olney St., Indianapolis, Indiana.	Sound producer for use with receiving sets.	$37.50	The throat and neck piece of this horn is made of a composition material resembling papier-mâché. The flared mouth is made up of segments of wood. The unit produces tones of good quality.
10.	Radio Lamp.	Faries Manufacturing Company, Decatur, Illinois.	To be placed on top of receiver cabinet for purpose of illuminating dials when tuning.	$ 6.00	A simple lamp enclosed in a metal case and supported on a movable arm, to be connected directly to lamp socket or base outlet. Finished in statuary bronze.

Recent Additions to the Radio Market Which Have Come to the Radio Broadcast *Laboratory for Our Examination and Approval*

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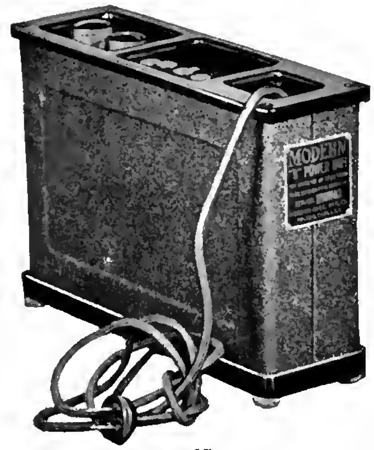

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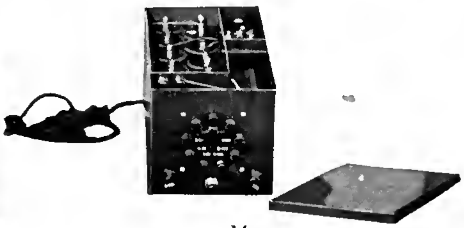

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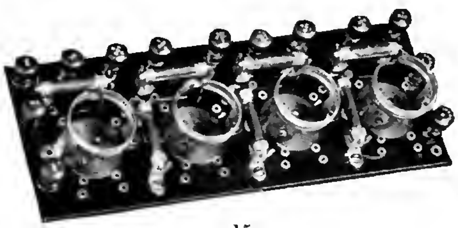

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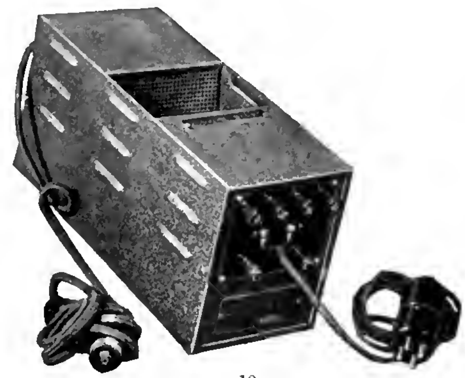

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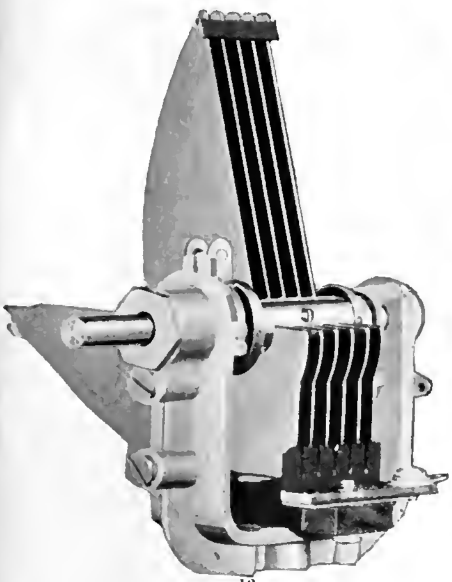
Radio Broadcast Photographs



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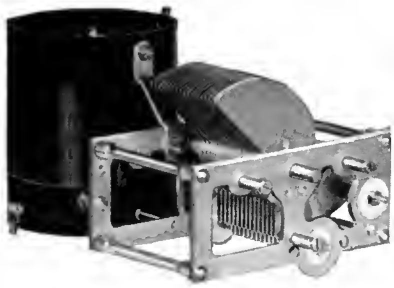

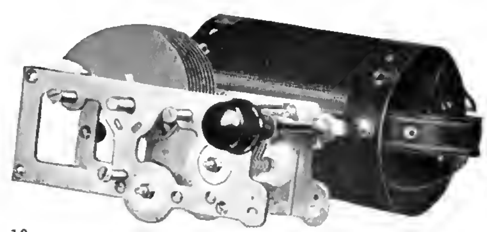

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No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
11.	Line Supply Device	Ferbend Electric Company, Chicago, Illinois.	Supply high voltage for plate of receiving sets.	$12.50 A. C. $ 9.75 D. C.	This type of line-supply unit employs a chemical rectifier to change the stepped up voltage to a pulsating d. c. A filter enclosed in the metal can smoothes this d. c. so that it may be used with receiving sets. For use on a 60-cycle line.
12.	Short-Wave Variable Condenser	Hammarlund Mfg. Company, 414 W. 33rd St., New York City.	For use in short-wave receivers.	$ 4.25	Double spaced plates to prevent accumulation of dust. The ball bearing arrangement provides smooth movement. Maximum capacity, 100 mmfd. Minimum capacity, 3 mmfd.
13.	Resistance-Coupled Audio Amplifier.	DeJur Products Compnay, 199 Lafayette Street, New York City.	Standard three-stage resistance amplifier for connection to output terminals of detector tube of a broadcast receiver.	$10.00	All connections to the various units employed in the amplifier are made underneath the panel. Bypass condensers are mounted underneath and are enclosed in the wooden box which forms the base.
14.	Superadio Line Supply Device.	Dewitt LaFrance Co., Inc., 54 Washburn Street, Cambridge, Massachusetts.	Supplies B and C voltages to receiver and audio amplifier.	$42.00	A chemical rectifier is employed in this device. Regulation of C voltage is by means of a control on the panel end of the unit. The detector voltage is also variable. For use on a 60-cycle line.
15.	Resistance Audio Amplifier and detector combined.	Heath Radio & Elec. Mfg. Company, 210 First St., Newark, New Jersey.	Detector and audio amplifier unit for use directly with tuning coils.	$10.00	A four-tube unit consisting of a detector stage and three stages of resistance-coupled audio amplification
16	Hydrometer.	In-A-Cap Hydrometer Co., 1343 W. 14th Place, Chicago, Illinois.	Test storage batteries to determine specific gravity of electrolyte.	$ 2.00 for three	The hydrometer glass is mounted in a battery vent so that when the latter is screwed in place, the hydrometer is ready for constant use.
17	Line Supply Device.	Modern Elec. Mfg. Company, Toledo, Ohio.	Supplies B voltages for receiver.	$50.00	A Raytheon tube is employed as a rectifier. The detector voltage is adjustable as is the voltage for the radio stages of a receiver. For use on 60-cycle line.
18	Power Amplifier and Line Supply Unit.	Timmons Radio Products Corp. Philadelphia, Pennsylvania.	Separate power audio-frequency amplifier operated by a. c. with plate supply for entire set.	$70.00 with tubes	This device employs the 210 tube as a power audio amplifier and the 216-B as a rectifier of the high voltage a. c. Three taps provide connection to the receiver proper for supplying plate voltages from 45 to 90 volts. For use on a 60-cycle line.
19.	Tuner Units.	National Company, Cambridge, Massachusetts.	Complete coil and condenser assemblies for use in receiver construction.	$24.00 a pair	The coils are space-wound with enamel wire on cylindrical tubing. The condensers, termed "Equicycle," give a straight frequency line characteristic.

Musical Reproduction Has Improved

How the Improvement in Loud Speaker Design Has Brought Well-Nigh Perfect Acoustical Reproduction—The Electrical Phonograph Allows the Perfect Combination With Radio

By A. F. VAN DYCK

Development Engineer, Radio Corporation of America

SINCE our subject is Modern Radio, there is no need to discuss radio as it has been in the past, and I shall refrain from the usual tracing of growth of the art from the beginning, in the belief that all of you are familiar with the milestones of radio progress. It would be possible to start with a description of Marconi's work, or even that of Hertz, or Maxwell, and continue right up to that of, say, Graham McNamee, but so much is happening in radio current events that we must, and can afford to, confine attention to the present day. My remarks at first will be very general and will probably seem very simple to Radio Club members, but there are a few fundamentals which it is well to recall once in a while so that we will not lose sight of the radio picture as a whole.

Radio broadcasting here requires most attention, of all the branches of radio, but I should like to mention the other branches briefly, for the sake of completeness, and to give a full and true picture of radio today.

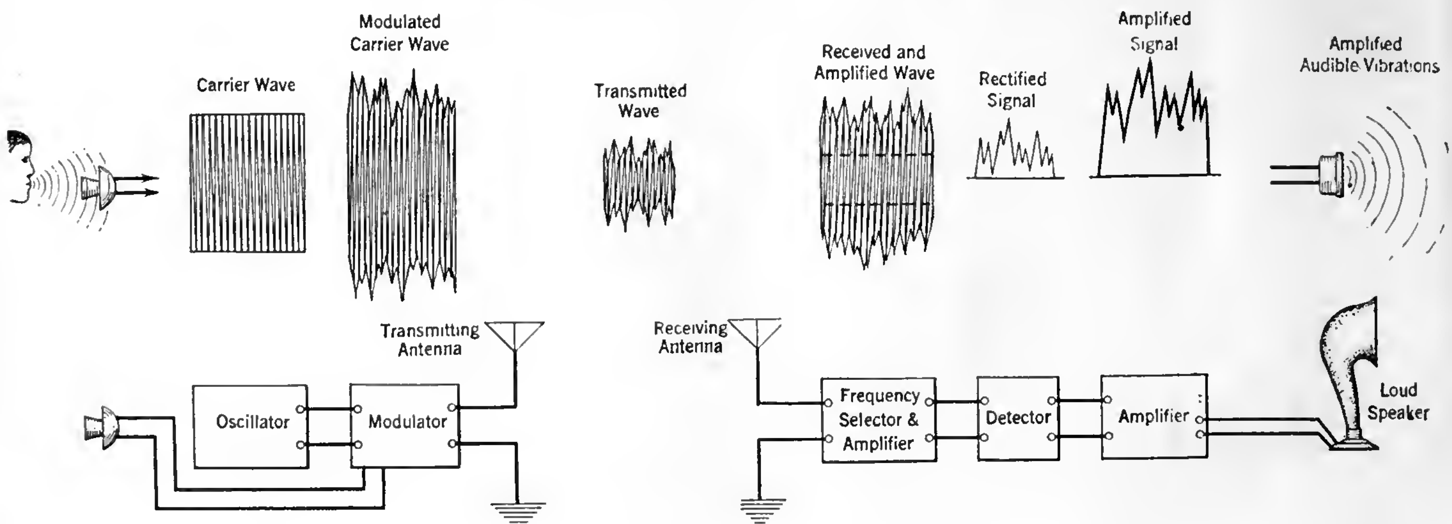
First, in transoceanic radio telegraphy, additional channels to South America, Central America, and Europe, have been added during the past year (1925). Channels to the Orient are being studied. Very soon, this country will have radio telegraph channels to nearly every important country. The importance of this service is quite obvious. International trade and international goodwill follow the courses of communication, wax and increase in effect with the enlargement of the contacts afforded by communication. The service afforded by radio in this field is steadily improving, not only in the number of channels existing, but in speed of operation, and various other technical respects.

Transoceanic radio telephony is not yet ready for public service use. Experimenting and development of technique are proceeding with great promise, but it is too early to see definitely the degree of success which this service may have, or the degree of usefulness which such service would have if technically satisfactory.

Marine radio telegraphy, that is, ship-to-shore communication, which is the oldest branch of radio, has improved steadily, and the ship service has reached a degree of speed, distance, and reliability which is quite remarkable, but which is accepted without remark or surprise, for this branch has long been considered an established public service. The halo of mystery and mysticism which once surrounded the radio operator at sea is no more, and he is accepted as part of a system of service understandable and fully established. There has been improvement in the apparatus used in marine radio, and some change in the frequencies (wavelengths) used, both of which have lessened the conflict of this branch with that of broadcasting in respect to interference.

Navigational radio, that is, the use of radio for the determination of position of ships at sea, and in general, their safeguarding when near coasts, is being extended in scope and usefulness. There can be no doubt that this service will eventually be the primary and unfailing means by which navigators may guide their vessels safely and surely, regardless of weather. I believe it is correct that eighty to ninety per cent. of sea disasters occur near the coasts, arising from ignorance of the true position of the ships, and it is therefore obvious that a method of location which is accurate and faithful at all times is of enormous help to navigation.

It should not be forgotten, in thinking of these marine uses of radio, that their interests are paramount. Broadcasting means entertainment and instruction to millions of people, but radio at sea often means safety of life to hundreds and thousands. Fortunately there has been no serious conflict of interests between these



HOW SOUND WAVES ARE BROADCAST AND RECEIVED

The broadcast transmitter is composed of two main parts, the oscillator and modulator systems. The former produces a steady signal called the carrier wave while the latter superimposes voice variations upon the carrier wave, so that the transmitted signal assumes a varying shape depending upon the variations in amplitude, which go to make up a complete radio signal. At the receiver, this wave must first be selected or tuned-in, then amplified at radio frequencies so as better to actuate the detector which rectifies and makes audible the radio signal, and then amplified at audio frequency to operate the loud speaker. At the transmitter, sound is changed into electrical energy by means of a microphone and at the receiving end, electrical energy is changed into sound by means of a loud speaker, causing a column of air to vibrate in synchronism with the vibrations of the diaphragm or other actuating mechanism of the loud speaker

Radio Broadcast Photograph

A GIANT HORN

Within predetermined limits, the longer the air column that is actuated within the walls of a horn, the more pleasing to the ear will be the signal delivered. The horn shown here has an exceptionally long air column which gradually increases in width, terminating at the bell of the horn, which is some 25 inches wide and 18 inches high. Despite its size, this horn is not unduly heavy on account of the composition employed

two branches, and they are developing side by side in amity and effectiveness.

BROADCASTING—THE PRECOCIOUS RADIO PRODIGY

AND so we come to broadcasting—the precocious prodigy of the radio family. This child is perhaps afflicted more or less with growing pains at present, but it is apparent that it has a strong and healthy constitution, and will have a long and useful life. Broadcasting has grown with an amazing rate, as you all know. Even during the past year its rate of growth has not lessened.

To-day, radio is an industry—a public service, filling a place in the daily lives of a large proportion of the people of this country, and of a sizable percentage of the people of the earth. Any device which extends the range or the power of the major human senses, and does so with sufficient similarity to the unaided sense, has instant appeal and widespread usefulness. Radio broadcasting is in this category, and hence, has had the stimulus of ready and increasing public demand.

The nature of radio broadcasting is such that an extraordinary interest in its purely technical aspects has taken hold of the public. Its nature is also so complicated technically, since it utilizes the most involved electrical relations known to electrical science, that it has been very difficult for the layman to grasp the subject adequately, or to separate its fundamentals from the interesting but non-essential matters.

To-day, nearly every automobile purchaser and owner understands the theory of automotive vehicles sufficiently well to be able to see clearly the differences between the various existent types, and he has little difficulty in choosing the type which most nearly meets his individual needs, desires, and preferences. For example, he knows that such vehicles require fuel, and that the fuel may be gasoline, steam, or electricity. Further, in the gasoline type, he knows that there is necessary a system of fuel feed to the motor, a fuel carburetion system, a fuel ignition system, a cooling system, a gear system, a braking system, and so on. He knows that there are certain types of body from which to choose.

Radio Broadcast Photograph

A NEW THIRTY-SIX INCH CONE

In this instrument are found several of the features which are predominant in the baffle board type of loud speaker construction. The cone itself is situated within a wide band or ring of wood which serves as the baffle board. In the rear, three arms attached to the baffle board support the driving mechanism which actuates the cone by means of a driving pin

Radio Broadcast Photograph

A TYPICAL HORN

This horn type of loud speaker depends entirely upon the movement of a column of air confined within the walls of the throat and bell of the horn to cause air vibrations which may be heard. The driving mechanism is a loud speaker unit of the conventional magnet and diaphragm type

Radio Broadcast Photograph

AN EIGHTEEN-INCH CONE

Of the several types of loud speaker illustrations accompanying this article, the eighteen-inch one shown above is a distinctive type. The cone proper consists of a front and back of convex shape. In an opening in the back is situated the operating mechanism connected by means of a driving pin, to the apex of the front side of the cone

Radio Broadcast Photograph

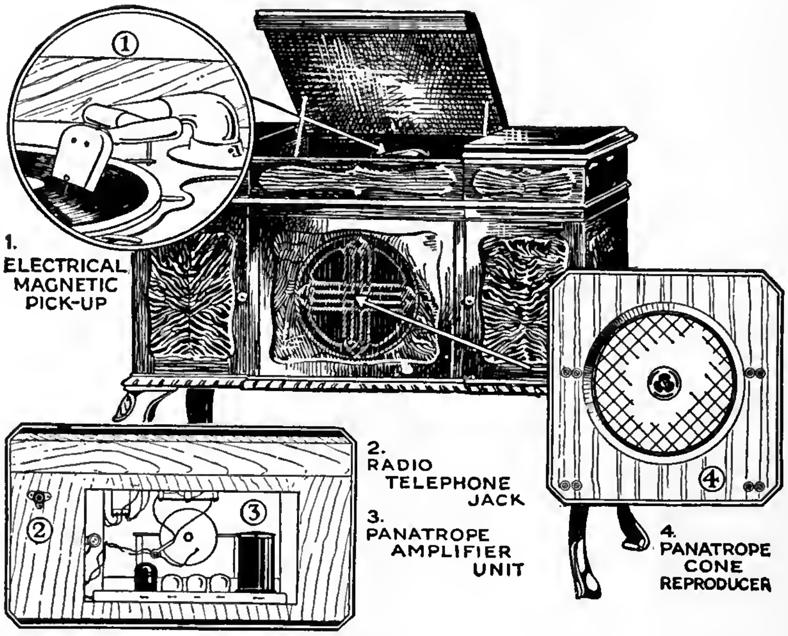
A "FREE-EDGE" CONE

Here is shown a recently developed loud speaker that employs two concave cones which are of the "free edge" type. The cones are so arranged that their apexes are brought to a common point at the driving mechanism, producing what might be termed a "push-pull" action

Similarly, in the radio receiver, there are fundamental considerations which govern design, and determine performance. We must consider also the radio transmitter, for the transmitted signal is the "fuel" of our radio system. Progress in transmission has kept pace with that in reception, and to-day it is true that good transmitters and good receivers are well matched in characteristics. A radio telephone transmitting station is an installation which sets up waves in the ether and does so by generating electrical currents in its antenna. These currents are alternating back and forth, thousands or millions of times per second, and this is the first fundamental which must be understood. The chief characteristic of a transmitting station is the frequency of these currents, or its wavelength. This frequency of the currents is also the frequency of the waves sent out in all directions, and waves of this frequency are therefore associated indissolubly with this station. If other waves originate from any other source, having this same frequency, they become interlopers, traveling under the disguise of our first station and entering into any receiver ready to receive that station. It can be seen readily, therefore, that every station should have a frequency all its own. This involves a radio problem which is perhaps the biggest one in the art to-day. I have said that each transmitting station requires a frequency at which it can radiate alone and undisturbed. Actually each station requires more than a single frequency—it needs a *band* of frequencies, rather than a single frequency. The frequencies of waves which can be utilized to-day by all branches of radio, range from about 15,000 cycles to about 15,000,000 cycles per second. This range is divided up among the various branches of radio service, and the part assigned to broadcasting, and in fact the only part which can be used satisfactorily for that purpose at present, lies between about 550,000 and 1,500,000 cycles. In other words, there is available for broadcasting, in the radio wave spectrum, a range of frequencies *about one million cycles wide*. The band of frequencies required by every radio telephone station is at least 10,000 cycles wide for reasons which need not be discussed here, and this figure can not be made less. Therefore it is obvious, by dividing one million approximately, by ten thousand, that there is room in the ether for about 100 broadcasting stations. Of course, if two stations were located so far apart geographically that their waves did not reach to the same points, they could use the same frequencies without any interference, but even our great country is not large enough to permit this duplication on a very large scale. At present this country has 578 broadcasting stations, instead of 100, and this has been arranged partly by dividing time of operation between two or more stations in the same territory, and partly by using the same frequencies for different stations. The ether is therefore overcrowded. The National Radio Conference called by Secretary of Commerce Hoover last fall, adopted a recommendation that no additional stations should be licensed, since more would simply add to the congestion. Various problems arising from this situation remain to be solved.

STRENGTH OF SIGNALS AT THE RECEIVER

THE strength of the signals at a receiver depends upon the strength of the waves reaching it, and the strength of



THE PANATROPE

This is the Brunswick phonograph employing electrical reproduction and amplification of sound. In this device, a baffle-board speaker, together with a power amplifier, produce plenty of volume of pleasing quality

the waves depends upon the power of the transmitter. Transmitters first used for broadcasting, had a power of $\frac{1}{2}$ kilowatt, mainly because that size transmitter was standard, being already in use in other services. As the quality of broadcast service improved, it became apparent that transmitters of this size did not deliver, at reasonable distance, waves sufficiently strong to dominate other electrical waves which also caused responses in receivers, and which originate in various electrical services. It is not sufficient, for good broadcast service, merely to be able to hear a transmitting station—its program must be clear from all other sounds to make its service really proper and enjoyable. Under this standard, the average year-round range of the $\frac{1}{2}$-kilowatt station is less than twenty-five miles, and under some conditions is as low as ten miles. Since such a small area of service per station is not economical, there has come about a general increase in the power of stations, until now thirty-two stations have one kilowatt, twenty-five have five kilowatts, and two are experimenting with as much as fifty kilowatts. It was feared at first by some, that higher power stations would interfere with other lower power stations. This was not expected by experts however, and actual experience has demonstrated high-power stations not only to be harmless, but to have realized the advantages sought. Stronger signals, with consequent greater freedom from interference, from static and other noises, is a most important improvement in modern radio.

The remaining part of our radio "fuel," which is of interest, is the program. This needs little description because you are familiar with its improvement. The entertainment and instruction provided by modern radio, the nation-wide broadcasting of nationally interesting events, has increased, with consequent improvement in quality of entertainment over the country at large.

A summary of modern radio transmission shows that high quality programs are available; transmitting apparatus, from the microphones to the antenna, has been refined, and stronger signals are being delivered to the receivers.

WHAT THE RECEIVER DOES

SO WE come to the receivers. Receivers are devices which transform traveling electrical waves of certain kinds into sounds. The more nearly the reproduced sounds are like the original sounds which operated the transmitter, assuming a perfect transmitter, the more nearly ideal is the receiver.

The fundamental parts of receivers are four in number. First, a wave pick-up system, or antenna; second, a tuning system; third an amplifying system, and fourth, a mechanism for converting electric currents into sounds, commonly called the loud speaker.

The pick-up system is necessary to intercept the traveling waves. When it does so, electric voltage is created in it. The tuning system is necessary to *select* that particular voltage which has the frequency which is desired, and reject all others. The antenna has electric currents in it resulting from all the various waves which pass it, but it is the function of the tuning system to increase the currents which are desired, and decrease the currents which are not desired. The degree to which it is capable of doing this determines the ability of the receiver to avoid interference from other stations. This ability is called "selectivity."

The amplifying system is necessary because the currents which are generated in the antenna and tuning system are exceedingly small, and must be made larger before they will be powerful enough to operate the loud speaker. These magnified, or amplified, currents, are fed into the loud speaker, and cause sound waves to be produced.

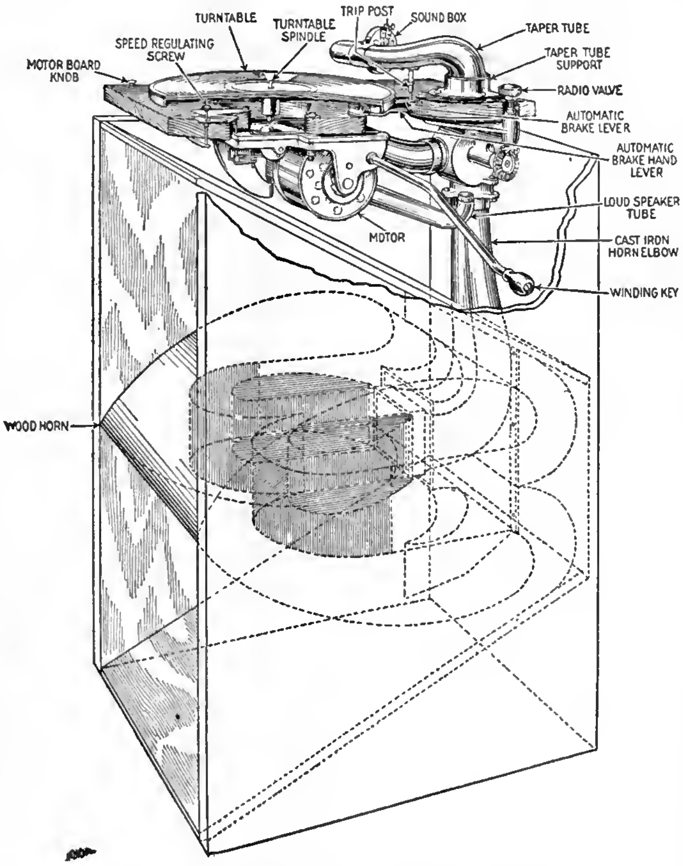
To repeat, the antenna system picks up energy from all waves, the tuning system selects the desired one, the amplifier amplifies it, and the loud speaker reproduces it. Now, each one of these parts, except the antenna, has been undergoing improvement continuously. All these parts were used in radio telegraph sets before radio telephony and broadcasting were developed—except the loud speaker. Consequently, they had been developed to a greater extent than had the loud speaker. Until very recently, the loud speaker was the "weak link" in the chain of parts of the broadcasting system. Tuning systems of various sorts, and amplifying systems of various types, both satisfactorily effective, were available, but the loud speaker was then subject to great improvement.

The outstanding feature of the past year, has been the development of loud speakers. Loud speakers are now available which accomplish their part of the receiver system work, as efficiently as the tuning and amplifier parts do theirs. This means that there is no longer a weak link in the chain of transformations of energy which take place between the microphone and the loud speaker. In fact, the improvement in loud speakers has been so great as to be startling to any one hearing it for the first time.

Radio receivers may be looked at in a different way, namely, from the performance point of view, instead of from the design point of view, as we have done so far.

To use the automobile analogy again—in buying a car, the buyer is interested in performance features, such as power, speed, acceleration, maintenance cost, comfort, ease of handling, and so on. The radio receiver owner is interested in performance features such as sensitiveness, selectivity, ease of operation, maintenance cost, and quality of reproduction. A proper degree of sensitiveness is required to permit the reception of long distance signals when desired. A sufficient degree of selectivity is necessary to permit the desired program to be picked out from all the others in the air without interference. The operative characteristics should be such that special skill is not required to operate the receiver, and that desired stations can be tuned-in quickly and, without fuss or difficulty. The maintenance care and cost must be small. The quality of reproduction must be sufficiently close to the original to be enjoyable and, to be ideal, must be such as will permit the illusion of the performer being in the room.

Of the four radio receiver fundamentals—sensitiveness, ease of operation, selectivity, quality of reproduction—the first two, sensitiveness and ease of operation, were incorporated in the very first broadcast receivers. The third, selectivity, was introduced as soon as the number of broadcasting stations had increased to the point where it was necessary. The fourth, quality of reproduction, was not so easy, and was not accomplished until recently. Of course, good reproduction by the receiver depends also upon good transmission quality at the transmitting station end of the system. There are many stations on the air to-day which will not reproduce properly on any receiver, no matter how good the latter may be. In fact, as many such stations sound worse, the better the receiver.



THE ORTHOPHONIC'S SOUND CHAMBER

This new Victrola differs greatly from the old type of phonograph because a carefully designed wood horn having a winding passage, as shown here, is used. Provision is made for the attachment of a loud speaker unit so that the horn may be used as a loud speaker. Unlike the Panatrope, the Orthophonic does not feature electrical reproduction

GOOD LOUD SPEAKERS ARE HERE

THE recent improvement in loud speakers has removed the last barrier to substantially perfect reproduction of sound. The steady improvement in broadcast programs, and the entrance of leading artists into broadcasting, have focused public attention upon the tonal quality and fidelity of the reproduction. Mere long distance reception, which usually involves weak and distorted signals, has simultaneously decreased in interest. Sustained interest, and real service, require high quality of reproduction, and I wish to emphasize, as the most important fact of modern radio, that high quality reproduction is now possible, as it never was before, and that it greatly enhances the value of broadcasting, and extends its service possibilities.

The fundamental requirements of a loud speaker to have perfect reproduction, are that it shall be omnitonal and equitonal. To be omnitonal, it must respond to all frequencies or pitches within audibility range, and to be equitonal it must respond to all frequencies equally, and proportionately to their intensities as performed. The faithful musical frequency range of loud speakers one year ago was less than four octaves. To-day the best types have a faithful musical range of seven octaves.

It should be understood clearly that high quality faithful sound reproduction by the loud speaker requires something more than the proper loud speaker. No matter how good the loud speaker may be itself, it cannot respond faithfully unless faithful, undistorted, currents are fed to it by the receiver. This means that the receiver must not distort the signals, but must select them and amplify them without loss or change of any tones. The amplifying part of the receiver is the most critical factor in reproduction, next to the loud speaker.

There is another characteristic of loud speakers which requires mention, in addition to faithfulness of reproduction. It is the volume, or loudness of sound, which it will deliver without distortion. This is dependent upon the nature of the receiver's amplifying system as well as upon the speaker itself. A loud speaker and its associated amplifying system should be capable of reproducing sounds to values as loud as the original, but modified to suit the room conditions at the point of reproduction. Good, modern reproduction is so like the original in this respect, that many of the precautions which have to be taken in the original rendition—for example, the location of pianos in the room—have to be followed with the loud speakers. It is quite likely, in fact practically certain, that many homes of the future will be designed with consideration of the acoustic characteristics of the rooms, in order that the fullest enjoyment may be had from high quality broadcasting.

THE ELECTRIC PHONOGRAPH

THE chief characteristic of radio is, of course, that its reproduction is simultaneous with the original performance, and is available at many different receiving points simultaneously. There is another form of reproduction which is also useful, that of reproducing, from a previously made record of the performance, at any desired later time. This is accomplished by the phonograph, and the magnitude of the phonograph industry is evidence of the usefulness of, and the demand for, this type of reproduction.

Even with a perfect radio broadcast service in existence there will still be the desire for hearing a particular artist, or a particular musical selection, at a particular time, and this need can be met only by the phonograph.

The phonograph reproduction capabilities available until recently were limited and were, in fact, about equal to those of the radio receivers available at that time. Now, however, the *electrical* phonograph has been developed, and this utilizes several parts found in radio receivers, so that the two instruments are closely parallel in technique, and in possibilities of reproduction quality.

The phonograph instrument with which we are all familiar through past years was mechanical throughout—from the making of the record to the final reproduction. In the recording process, the sound waves of performance acted upon a diaphragm to which was attached a cutting tool, this latter being moved by the vibrations of the diaphragm and which cut impressions upon a wax master record. The final records, when played upon the phonograph, gave vibrations to a diaphragm through movements of a needle attached to the diaphragm and bearing upon the record. The diaphragm movements set up air sound waves which were amplified by a horn attachment. All of these processes were, therefore, dependent upon small mechanical forces and employed mechanical resonance, which prevented equal response to all frequencies. There have been great improvements in this type of phonograph recently, with which most of you are doubtless familiar.

ADVANTAGES OF THE ELECTRICAL PHONOGRAPH

IN THE electrical phonograph, we have further possibilities. Electrical forces are more easily and more flexibly controlled and used than are purely mechanical forces. In electrical recording, the tool which cuts the master record can be actuated by electrical means, and the electric power for this be obtained from powerful amplifiers, which, in turn, are fed by sensitive and faithful pick-up devices. For example, the artist may perform before a microphone of the broadcasting type, or its equivalent, and the electrical output of this microphone can be amplified faithfully to any power necessary to operate the record cutting tool. In other words, the power necessary to cut the record does not come from the voice of a singer, for example, but from the power supply of the amplifier. This means that modern records are more nearly omnitonal and equitonal than old type records, and considerable improvement in phonograph reproduction results.

On the reproducing end, the needle which runs in the record groove and is moved thereby, can be attached to a tiny electric generator which will generate currents exactly in accord with the movements of the needle. These small currents can be amplified, by an amplifier identical with those used in radio receivers, and the amplifier output transformed to sound by a loud speaker, also identical with those used in radio receivers. This process is therefore electrical from beginning to end, and is practically omnitonal and equitonal, that is, it reproduces all the musical frequencies, and reproduces them equally and proportionately to original intensities. All the technique of vacuum tube and loud speaker practice is therefore directly applicable to the phonograph art, which benefits accordingly.

Since the electrical phonograph is operated entirely by electricity, and electrical forces can be amplified to any desired extent by vacuum tubes, and can be controlled easily, we find that it is capable of producing enormous sound volume when desired, and that the sound can be reduced to a whisper when desired. The instrument is therefore suited to reproduction under all conditions of the home, as well as being capable of supplying sufficient volume for a large auditorium.

To demonstrate the capabilities of the electrical phonograph, a series of records can be selected, to be chosen not with the idea of providing a balanced program of entertainment, but to illustrate the technical performance features. Records of various kinds, orchestral, band, choral, and vocal, can be used to see how faithful the reproduction is compared with the original. In particular, in vocal-choric work you will be able to distinguish the individual voices clearly, and in orchestral selections—the individual instruments. This is possible only when practically all frequencies are being reproduced faithfully. Also in speech and song, note the intelligibility.

I believe that any one who has heard the modern radio and electrical phonograph instruments will agree that there has dawned a new era in sound reproduction. It is my own belief that such reproduction has now reached the stage of development, where it is ready to provide a public service of complete merit, and of inestimable value.

And that is the thought I would leave with you—that science, in its continual struggle to master and use the infinite resources of Nature, has given another service to mankind, to make life broader, more enjoyable, and more valuable.

Results in the Short-Wave Receiver Contest

TO ANSWER the questions of many readers who have been interested in the RADIO BROADCAST-Eveready short-wave receiver contest, the following facts will be of interest.

At the present time there is no amateur short-wave receiver that is in general use that does not radiate. This means that each of the 16,000 and more amateurs who are listening on the short-wave bands with their Reinartz and other simple receivers is endangering the reception of his fellow amateurs due to the fact that his receiver is not only a receiver—it is a small transmitter as well. It is true that this disturbance is small, and is confined to a limited area, but every one remembers the early days of broadcasting when practically all of the receivers in use were "bloopers." And so much interest has been displayed in short-wave reception, and so many queries have come to RADIO BROADCAST'S experimental station 2GY for receiver circuits, that the Editors have not felt free to advise the further construction of blooping receivers.

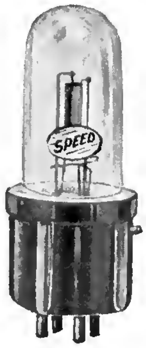
For these reasons, three prizes totalling $500 were offered for non-radiating amateur short-wave receivers. Some twenty-five manuscripts were selected for submission, but only about fifteen were considered since the others were hopelessly out of the contest. Of the final fifteen, three were eliminated in favor of twelve, and these twelve receivers were actually tested in the Laboratory.

Now one would think that three out of the twelve could satisfy the conditions of the contest as set forth in the February RADIO BROADCAST. Unfortunately, however, every one of the receivers radiated, some more, some less, and there seemed to be a definite relation between the sensitivity of the receiver and its radiation. In other words, the more sensitive the more it radiated—usually due to closer coupling to the antenna.

Owing to these facts, it has been manifestly impossible to award three prizes as originally planned. With the permission of the judges in the contest, the following plan has been worked out.

From the twelve receivers the three best have been selected, that is the three which most nearly meet the conditions of the contest. These three are sensitive and radiate less than the standard Reinartz which is in use at 2 GY. The best of the three will be awarded $100. in addition to the usual rate paid for articles. While it is not claimed that this receiver will receive more stations or weaker signals than the Reinartz, nor can it be said to be absolutely non-radiative, it is felt that it will be a considerable improvement over the blooper now in use. The winner will be announced in September RADIO BROADCAST.

It is not impossible to build a non-radiating short-wave receiver. No less an amateur than Dr. A. Hoyt Taylor assures us of that—why doesn't some amateur do it? The editorial pages of RADIO BROADCAST are always open to receivers whether for broadcast or amateur bands that are distinct improvements. We can think of no single thing that is more needed than a non-radiating short-wave receiver that is simple to build and to operate.—THE EDITOR.



The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of Radio Broadcast *have until recently been answered either by letter or in "The Grid." The latter department has now been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," we present herewith a series of Laboratory Information Sheets. These sheets contain much the same type of information as has appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* Radio Broadcast *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears elsewhere in this issue. The June and July issues of Radio Broadcast*, in which appeared the first two sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company.*

No. 17 Radio Broadcast Laboratory Information Sheet August, 1926

Inductance of Single-Layer Solenoid Coils

CALCULATION FORMULA

IT IS possible to obtain quite a close approximation of the inductance of a solenoid coil by the use of the Bureau of Standards formula, which is as follows:

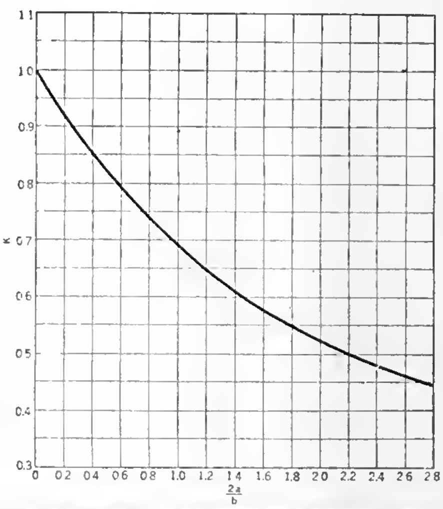
$$L = \frac{a^2 n^2}{10b} K$$

in which—
L = Inductance of coil in microhenries.
a = Radius of coil in inches, measured from the center of the coil to the center of any wire.
b = Length of coil, in inches.
n = Number of turns.
K = A constant, depending upon the ratio of $\frac{2a}{b}$.

The constant K in the formula can be obtained from the accompanying curve.

This formula can be used very well in determining the approximate inductance of any particular coil, or can be used to determine the number of turns necessary in order to give certain inductances.

It does not take into account the shape or size of the wire, nor does it consider the effect of the capacity of the coil. However, since the coil capacity is usually negligible in comparison with the capacity of the tuning condenser, it is not especially important insofar as the tuning range of the coil is concerned.



No. 18 Radio Broadcast Laboratory Information Sheet August, 1926

Volume Control

CORRECT METHOD TO USE

A GREAT many of the present receivers now in use are not equipped with any really satisfactory means of volume control. The most common method used on these receivers is to control volume by means of one or more filament rheostats. Usually these rheostats control the audio frequency tubes and, when such is the case, the quality is sure to suffer when the volume is reduced by lowering the filament current. Under such conditions, the quality will be impaired due to the two following causes.

In the first place, lowering the filament temperature will increase the plate impedance. Now the frequency characteristic curve of any audio transformer depends to a great extent upon the impedance of the plate circuit. If this impedance is high, the quality will be poorer than if the impedance was low and, for best results, the impedance of the transformer primary should be at least three times the impedance of the plate circuit. Lowering the filament temperature will destroy this ratio, and the quality thereby becomes poorer.

In the second place, lowering the filament temperature has the same effect as increasing the negative grid bias. If the temperature is lowered to any great extent, the tube will operate on the lower bend of its characteristic curve and distortion of the signals will then take place because a certain amount of detection will occur. Detection should only take place in the detector circuit and, if it occurs at any other point, it will invariably cause distortion.

If volume control is at present being accomplished by filament rheostats in the audio amplifier, it will be wise to revise the set so as to permit the use of some other system.

Volume can be controlled quite satisfactorily by means of a potentiometer across the secondary of the first audio transformer. This resistance will, actually, somewhat better the quality, since, if a rather poor transformer is being used, it will smooth out the amplification curve and make it quite flat. This unit should have a maximum resistance of about 500,000 ohms, and should always be placed across the first audio transformer. It is then possible, on strong signals, to cut down the volume and incidentally prevent overloading of the audio tubes. However, if the resistance were connected across the second transformer, it would not be possible to prevent overloading of the first tube. Connection across the first transformer is, therefore, advisable.

It is also possible to control volume very nicely by means of the filament rheostat controlling the radio frequency tube, without getting into any of the difficulties that occur if filament variation of the audio tubes is used to control volume. This is due to the fact that variations in the plate impedance of the radio frequency tube merely tend to cut down the overall amplification, but there is no possibility of frequency distortion since we are working with what is practically a single frequency.

No. 19 RADIO BROADCAST Laboratory Information Sheet August, 1926

Learning to Read Code

A GOOD CIRCUIT TO USE

ONE of the best methods for use by a novice in learning the code is to construct a simple receiver capable of receiving the long wavelengths ranging from 600 to 15,000 meters (500 to 20 kc.). Practically all of the transatlantic stations operate on these low frequencies, and usually the transmitting is done at a fairly low speed, so that it is possible for anyone with just a rudimentary knowledge of the code to decipher quite a few letters. In a comparatively short time it will be found possible to receive whole words—and then sentences.

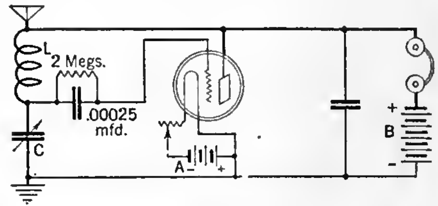
The circuit diagram of a long-wave receiver that can be used to receive code signal is shown in the accompanying diagram. L is a honeycomb coil, the size of which depends upon the wavelength it is desired to receive. Condenser C is an ordinary 0.001-mfd. variable condenser. Forty-five volts of B battery is sufficient. This receiver is regenerative, and feedback is controlled by variation of the 20-ohm filament rheostat.

The receiver should be connected to an antenna about 100 feet in length, and a good ground should be used. Most of the long-wave stations operate on pure c. w. which means that the antenna at the transmitter is fed from a high frequency oscillator, the output of which is controlled by the key. When the key is depressed the set breaks into oscillation, and when the key is raised the set stops oscillating. Therefore, the energy radiated into the air consists of a series of high frequency impulses. These signals are not audible until they are heterodyned by the oscillations that take place in the receiver. Therefore, in using this receiver, the filament rheostat should be advanced until the set oscillates.

A copy of the International Morse Code is shown on Sheet No. 20.

The following table gives the coil sizes for L to cover the various wavelength bands commonly used—

600-meter traffic, L =	100 to 150-turn coil
1200–2600 " " , L =	300 to 400 " "
2600–5000 " " , L =	750 " "
5000–15,000 " " , L =	1500 " "



No. 20 RADIO BROADCAST Laboratory Information Sheet August, 1926

The Continental Morse Code

A	· —
B	— · · ·
C	— · — ·
D	— · ·
E	·
F	· · — ·
G	— — ·
H	· · · ·
I	· ·
J	· — — —
K	— · —
L	· — · ·
M	— —
N	— ·
O	— — —
P	· — — ·
Q	— — · —
R	· — ·
S	· · ·
T	—
U	· · —
V	· · · —
W	· — —
X	— · · —
Y	— · — —
Z	— — · ·

Ä)German)	· — · —
Á or Å Spanish-Scandinavian	· — — · —
CH (German-Spanish)	— — — —
(É French)	· · — · ·
(Ñ Spanish)	— — · — —
Ö (German)	— — — ·
Ü (German)	· · — —
1	· — — — —
2	· · — — —
3	· · · — —
4	· · · · —
5	· · · · ·
6	— · · · ·
7	— — · · ·
8	— — — · ·
9	— — — — ·
0	— — — — —

Period	· · · · · ·
Semicolon	— · — · — ·
Comma	· — · — · —
Colon	— — — · · ·
Interrogation	· · — — · ·
Exclamation Point	— — · · — —
Apostrophe	· — — — — ·
Hyphen	— · · · · —
Bar indicating fraction	— · · — ·
Parenthesis	— · — — · —
Inverted Commas	· — · · — ·
Underline	· · — — · —
Double dash	— · · · —
Distress Call	· · · — — — · · ·
Attention call to precede every transmission	— · — · —
General inquiry call	— · — · — — · —
From (de)	— · · ·
Invitation to transmit (go ahead)	— · —
Warning-high power	— — · · — —
Question (please repeat after ______)interrupting long messages	· · — — · ·
Wait	· — · · ·
Break (double dash)	— · · · —
Understand	· · · — ·
Error	· · · · · · · ·
Received (O.K.)	· — ·
Position report (to precede all position messages)	— · — ·
End of message (cross)	· — · — ·
Transmission finished (end of work)	· · · — ·

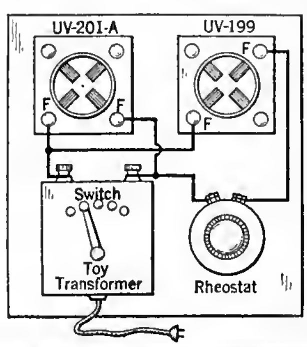
No. 21 RADIO BROADCAST Laboratory Information Sheet August, 1926

Rejuvenating Tubes

CONSTRUCTION OF A SUITABLE UNIT

IT NOT infrequently happens that, with tubes having thoriated filaments, the emission gradually decreases after considerable use so that the tube is rendered useless, even though the filament still lights. Under such conditions, it is usually possible to subject the tubes to a treatment that will put them once more in usable condition. This treatment is called reactivation, or rejuvenation, and is quite easily accomplished by the home experimenter with a few fairly cheap parts that can easily be assembled into a suitable instrument for reclaiming apparently useless tubes. Many tubes will, after reactivation, give off as much emission as they did when new.

The parts needed to assemble a rejuvenator are a toy transformer of the type usually employed to operate small electric trains, two tube sockets, one for 199's, and the other for 201-A's, a 30-ohm rheostat, and some odd screws, nuts, etc. The connections are clearly shown in the accompanying diagram.



Practically all toy transformers have on the top of the case a small switch by means of which the secondary voltage can be raised or lowered. Voltages from six to twelve can usually be obtained.

Suppose we desire to reactivate a 201-A. The tube is placed in the 201-A socket (which is the left hand socket in the diagram) and the plug connected to the 110-volt alternating current supply. The tap switch is set for twelve volts and the tube is allowed to burn at high voltage for about one minute. The voltage is then reduced to six or seven volts, and the tube is permitted to "cook" for about one-half hour. It can then be removed and, generally, when placed in a receiver, it will be found to give entirely satisfactory operation.

The procedure to be followed in treating a 199 tube is practically the same. At first the tube is "flashed" at eight volts for half a minute. The switch is then placed at the lowest voltage, which is usually about six volts, and then the rheostat is used in order to reduce the voltage to $4\frac{1}{2}$ volts. With this applied voltage the tube is cooked for half an hour, when the treatment is complete.

The voltages given above are only approximate and need not be followed exactly. The rheostat for 199's is not essential, and if it is dispensed with, the tube should not be cooked as long at the higher voltage.

No. 22 RADIO BROADCAST Laboratory Information Sheet **August, 1926**

A Simple Loop Receiver

GENERAL DATA

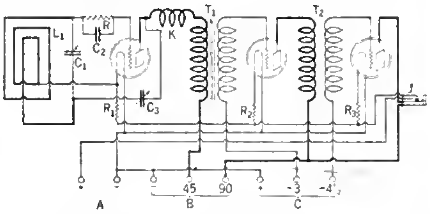
IT IS possible to make up a very simple yet quite efficient loop receiver using condenser feedback for the control of regeneration. Such a receiver will be useful for local reception when sufficient audio frequency amplification is added. If the receiver is made up in the form of a portable set, it will also be found extremely valuable in locating sources of interference.

The circuit diagram of such a receiver, using two stages of audio amplification, is given herewith.

- L_1 = Any standard loop designed for operation with a 0.0005-mfd. variable condenser.
- C_1 = 0.0005-mfd. variable condenser.
- R = 5-megohm grid leak.
- C_2 = 0.00025-mfd. grid condenser.
- C_3 = 0.00025-mfd. variable condenser used to control regeneration.
- K = Radio frequency choke coil. This coil may consist of about 300 turns of No. 30 d.s.c. or other fine wire, bank wound on a 1-inch tube.
- T_1 and T_2 = Audio frequency transformers.
- J = A single-circuit filament control jack.
- R_1, R_2, and R_3, = filament ballast resistances of type satisfactory for the kind of tubes employed.

If the set is to be designed for portable use, UV-199 tubes are recommended and, in this case, it will be best to supply the filaments with three 1½-volt dry batteries in series. The tuning of such a receiver is quite simple and depends entirely upon the setting of the condenser C_1. As in any regenerative receiver, maximum volume will be obtained when the detector tube is adjusted so as to operate slightly below the oscillating point, this adjustment being controlled by variation of condenser C_3.

Particularly in interference investigations the directional effects of the loop will be found very valuable, the loudest interference being received when the plane of the loop is pointed toward its source.



At all times during the operation of the receiver, care should be taken so as to keep the detector tube below the oscillating point since, if this tube does oscillate, a certain amount of radiation will take place which will produce interference with other receivers. Since a loop is being used, this radiation will not be very great, however.

No. 23 RADIO BROADCAST Laboratory Information Sheet **August, 1926**

Rheostats

DETERMINING CORRECT VALUES

ON THIS sheet are given data regarding the amount of resistance necessary in a single rheostat in order to control various numbers of tubes. The values of resistance that are given are just sufficient to reduce the battery voltage by the necessary amount, and if it is desired to operate the tubes at somewhat below the rated voltage (not altogether a good practice), rheostats with about 50 per cent. more resistance than specified, should be used.

In any case, it will generally be found impossible to obtain rheostats with the exact resistance given in the table, and it will be necessary to use the next larger size. It should be noted that two lines are given to both the 199's and 12's to cover the use of either dry cells or a storage battery.

NUMBER OF TUBES IN PARALLEL → / TYPE OF TUBES ↓	1	2	3	4	5	6	7	8
				RESISTANCE IN OHMS				
201-A—With 6-Volt Supply	4	2	1.5	1	.8	.7	.6	.5
199—With 4½-Volt Supply	25	13	9	7	5	4.5	4	3
199—With 6-Volt Supply	50	25	17	13	10	9	8	7
12—With 1½-Volt Supply	1.6	.8	.6	.4	.4	.3	.25	.2
12—With 2-Volt Supply	4	2	1.2	.9	.75	.6	.55	.45
112—With 6-Volt Supply	2	1	.7	.5	.4	.35	.3	.25
120—With 1½-Volt Supply	12	6	4	3	2.5	2	1.7	1.5
120—With 6-Volt Supply	24	12	8	6	5	4	3.5	3

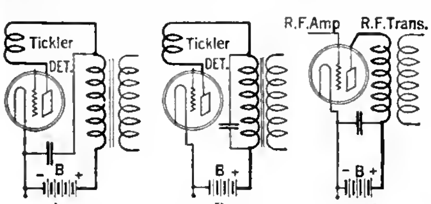
No. 24 RADIO BROADCAST Laboratory Information Sheet **August, 1926**

Bypass Condensers

RULES FOR LOCATION

AT SEVERAL locations in a receiver it is essential that bypass condensers be used and, at several other points, their use is advisable.

In practically all receivers, a bypass condenser is necessary across the primary of the first audio transformer, which is, of course, connected in the plate circuit of the detector tube. In those cases where transformer coupled amplification is not used, the condenser should be placed across the impedance or resistance in the detector plate circuit, depending upon whether an impedance- or resistance-coupled amplifier is used. In any event, the method of connection shown in A, is to be preferred to the method shown in B.



With the former method of connection, the radio frequency currents are returned, by the condenser, directly to the filament and do not need to pass through the B battery. The condenser used at this point should not be larger than is necessary to give good results. Usually a 0.00025-mfd. condenser is large enough, and a 0.001 one should not be used unless it is found necessary.

It is frequently wise to place a large bypass condenser across the B battery. This condenser, which should have a capacity of about 1 mfd., bypasses the audio currents around the B battery.

A condenser connected as shown in C, will usually be found of value in obtaining more stable operation from a radio-frequency amplifier. If this condenser is not used, the r. f. currents, in returning to the filament, must pass through various leads and then through the B battery and, quite possibly, there will be sufficient coupling to other parts of the circuits to prevent accurate neutralization. This condenser should have a value of not less than 0.1 mfd.

The function of any bypass condenser is to return certain currents, by as short a path as possible, to the tube where they originated. A bypass condenser is practically worthless if connected to any part of the circuit without giving regard to this rule. Therefore, whenever possible, one side of the bypass condenser should connect to the filament terminal of the socket containing the tube to which the currents are to be returned.

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prize winner for the last period is announced at the foot of *page 340.* *Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* RADIO BROADCAST, *Garden City, New York.*

Control for Raytheon Eliminator

ACCORDING to the directions furnished with the Raytheon tube for use in a line supply device, the maximum output voltage should not exceed 150, otherwise the tube heats up badly, and injury may result.

The writer has a four-tube set and found that even on the low voltage tap the amplifier output voltage was around 180 volts. This problem was solved by the use of a "Dim-a-lite" socket. This is a socket that burns a lamp at four different light intensities due to a resistance inside, which may be set at four different values.

The socket was hooked up to the 110-volt supply and the line supply unit was in turn plugged into the "Dim-a-lite" socket. Adjusting it to the first voltage brought the output voltage of the line supply to just 145 volts.

This arrangement will also prove very useful when too low a voltage is secured on the low tap and too high a voltage on the high tap, which will occur with the larger sets.

It can also be used for the same purpose, namely a primary resistance, in any other similar transformer arrangements where the voltage is normally too high.

EDWARD J. FANLEY,
Columbus, Ohio.

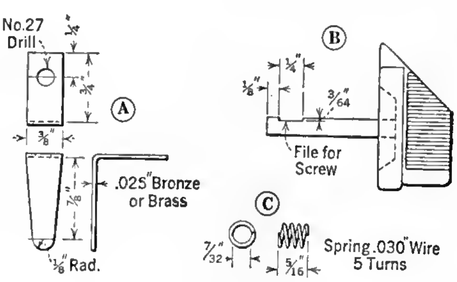


FIG. 1

A Combined Rheostat and Voltmeter Switch

SO THAT the correct filament voltage may accurately be applied to the vacuum tubes in a receiving set, many manufacturers advocate the use of a voltmeter. When, as is generally the case, one meter is to be used to take the reading of each tube individually, some switching arrangement becomes vital so that the meter may rapidly be switched across the filament posts of the tubes without the necessity of changing connections, etc. It is a simple matter to obviate this switching arrangement and, in the writer's case, a combined rheostat and voltmeter switch was designed to accomplish this. Such a gadget, in addition to saving panel space, is considerably handier to operate than is a switch; and it is not difficult to make. The contribution of a couple of supplementary parts to the standard Pacent rheostat is all that is necessary.

On these Pacent rheostats, two bindings posts are provided, one of which connect with the sliding arm which, in turn, makes contact with the resistance wire. In a receiver, this binding post must be connected to the minus A terminal of the tube socket. The other binding post is connected to the minus A lead from the storage battery. To complete the battery circuit, the plus terminal of the A battery is led to the remaining post of the tube socket.

Between the two binding posts of the rheostat will be found a hole, and into this hole—from the inside—is inserted a $\frac{1}{2}$-inch No. 6/32 brass screw. This screw holds a specially-made brass angle-piece which, when a reading is taken. makes contact with the shaft (and therefore, via the sliding arm, to the minus A terminal of the tube socket). In Fig. 2, this screw is indicated by the lettering "Connect to Voltmeter," while the details for the brass (or phosphor bronze) angle-piece are shown in A, Fig. 1.

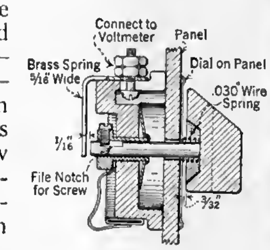


FIG. 2

The next procedure is to file a small notch $\frac{1}{4}$ inch in width in the shaft. This is made clear by reference to B, Fig. 1. If the panel is 3/16 inch thick, the $\frac{1}{8}$-inch notch will make a gap of $\frac{1}{16}$ inch between the brass angle-piece and the tip of the shaft. If a thicker panel is employed, decrease the $\frac{1}{8}$-inch dimension at the end of the shaft accordingly. The reassembly of the rheostat is now begun, but not before a washer and spring of the specifications given in C, Fig. 1, are procured. These are placed between the panel and the rheostat knob, as shown in Fig. 2. The assembly details can be followed by reference to Fig. 2.

When the voltmeter is being wired into a set employing these combination rheostat-voltmeter switches, it should be connected, the minus terminal to the screw supporting the brass angle-piece, and the positive terminal to the A plus binding post on the set. In Fig. 3 are shown the connections when several tubes are employed.

If the above connections are carefully adhered to, by simply pressing-in the knob of either of the rheostats, the voltmeter will be thrown into circuit, and its reading will indicate the filament voltage of the particular tube controlled by that rheostat.

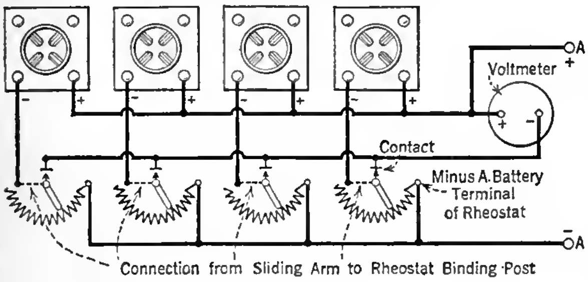


FIG. 3

The spring will keep the voltmeter out of circuit except when the rheostat knob is subjected to pressure.

H. E. CARLSON,
East Saugus, Massachusetts.

IMPROVING THE NP COIL FOR THE ROBERTS RECEIVER

MANY constructors of the Roberts receiver, who have set out to construct their own coils, have met with certain difficulties. Either the receiver tunes broadly on the wavelengths in the vicinity of the local station's wavelengths, or it cannot be neutralized for all wavelengths, or perhaps it has certain dead spots. These faults can usually be attributed to the design of the NP coil.

In the regular NP coil, two wires are wound simultaneously on the spiderweb

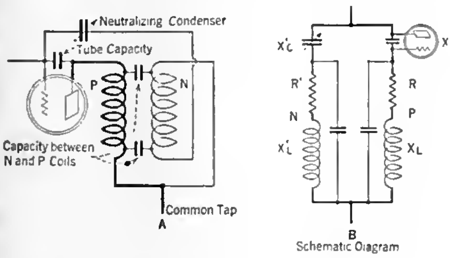


FIG. 4

form. Frequently these wires are twisted together before winding. In either construction the inside of one winding is connected to the outside of the other winding.

These coils constitute two circuits, one counterbalancing the other. Fig. 1, A, B, shows the usual representation and a schematic representation of these circuits. Each of these consists of resistance, inductance, and capacity, as shown in heavy ink. The light ink indicates capacity that is present as tube and distributed capacities. To obtain a coil that will neutralize for all wavelengths, it is necessary to have the same quantity of inductance and resistance in each of the two coils. In the event that the two coils are tightly wound together throughout their length, it will be found that the receiver has dead spots

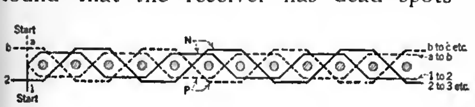


FIG. 5

and will tune broadly on local stations. This last fault is caused by the large losses between the two coils coupled by a large amount of distributed capacity.

The following coil design has been found to eliminate all of these difficulties and makes the spiderweb coil a desirable coil for this receiver. To wind this coil, two lengths of wire are wound simultaneously on the spiderweb form, one wire is wound on one side of the form, under two and over two, and the other wire, under two and over two, on the other side of the form. Fig. 5 clearly indicates how this method of winding separates the two coils so that the distributed capacity is reduced to a minimum and at the same time permits the construction of coils of equal constants, to assure proper neutralization over the whole wavelength range.

H. C. RUSSELL,
Arnold, Pennsylvania.

IMPROVING PHONE DIAPHRAGMS BY REVERSING

DIAPHRAGMS in ear phones or in loud speaker units, used in radio reception, will become concave or "set" after the parts have remained assembled for a long time. The magnetic pull of the permanent magnets in the coils drags the discs, and these assume a cup shape, with the center surface of the metal closer to the magnets than when originally constructed.

Reversing these diaphragms increases the distance from the disc to the magnet, but after a short time the disc again assumes a normal flat surface.

As will be evident from a consideration of the phone, the concave plate is not as responsive to the magnetic pulsations as will be the flat disc, or a disc reversed so that the magnetic pull will be in a direction that will tend to deflect the diaphragm.

A test to determine the concavity of the disc is made by simply placing a straight edge, as a ruler, across the face of the disc, as in Fig. 6. This will show, in an old set of phones, that the center of the disc is set back, sometimes as much as one thirty-second part of an inch or more.

It is not advisable to hammer or attempt

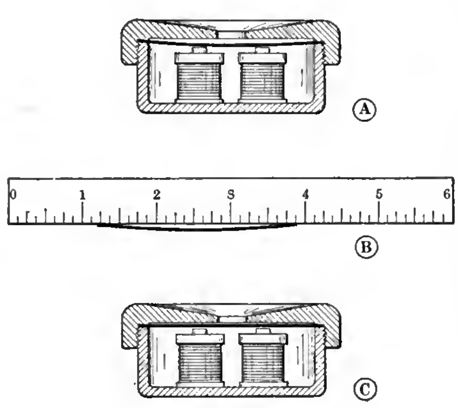


FIG. 6

to twist the disc to shape, as the accuracy required is too much for the average person to gauge, and better results are generally obtainable simply by reversing it.

In Fig. 6, A shows how the diaphragm is warped after constant use; B shows how the disc is tested by placing it against a straight edge, such as a rule; and C indicates the position of the diaphragm after it has been reversed.

G. A. LUERS,
Washington, District of Columbia.

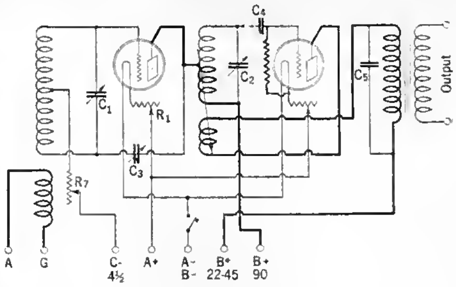


FIG. 7

Oscillation Control of the "Universal"

IN EXPERIMENTING with the Radio Broadcast "Universal" Receiver, I stumbled upon an idea which I found increased the volume of the receiver many fold, stabilized it, and considerably simplified the control of oscillation and regeneration. This was accomplished by putting a resistance in series with the negative of the C battery and center tap of the secondary coil, L2, as shown in the accompanying diagram, Fig. 7.

The resistance I used was a Bradleyohm, 10,000 to 100,000 ohms. It worked best when set at its minimum resistance. I would suggest that other sizes and kinds of resistances be tried. In my set I employed the variable tickler method of regeneration control.

Conrad Philbrick,
Olympia, Washington.

Switch Control For Battery, Line Supply, and Charger

AFTER purchasing a line supply unit, I realized that it would be a nuisance to have to turn off two switches in order to cut off both the A battery and the line supply from the set. Investigation and consultation both demonstrated that anything I did toward the unifying of these controls would have to be original, for there seemed to be nothing on the market specifically designed for the purpose. A little thought evolved the scheme showed in Fig. 8, A, in which the switch is a Carter or Yaxley panel mounting jack switch, single pole, double throw.

Then the addition of a trickle charger complicated matters somewhat. In my case, the current consumption was so high that I found it advisable to have the charger going whenever the set was not in operation. Further investigation showed but one suitable device to apply. This was the Brach power control, which turns off the line supply and turns on the charger. There were two objections to such a system, however.. First, the necessity for a separate switch to control the A battery input and, second, that the unit did not lend itself well to being built in. A jack switch again provided the means for doing what I desired—turning off the A battery from the set, turning off the 110-volt line to the line supply unit, and connecting the trickle charger to the 110-volt line. Fig. 8, B, shows how this was done. A double pole, double throw switch on the panel controls the three circuits. As added conveniences, I included in the battery cabinet three plug receptacles and a socket for a series lamp in the charger circuit—one plug for the line supply, one for the charger, and one connected to the 110-volt line without switch for occasional connection of the tube rejuvenator. The series lamp in the charger line has two features; it regulates the rate of charging, and it provides light in the battery compartment for inspection of the battery and charger. The trickle charger may be disconnected at any time by unscrewing the lamp. The use of socket and plug on the units gave the built-in feature, and at the same time provided ease of removal of any unit. Of course, this arrangement is applicable to any type of charger, the charger being plugged-in only as needed.

Gordon T. Williams,
Cleveland, Ohio.

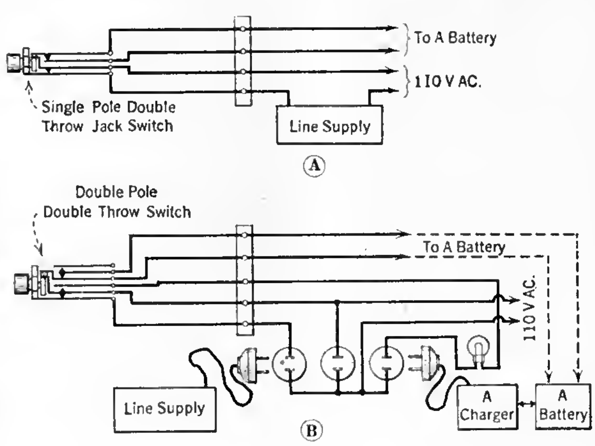


FIG. 8

A Novel Method for Neutralizing Condenser Adjustment

HERE is a simple method for neutralizing condenser adjustment.

The method can be applied to any set employing one step of neutralized radio frequency amplification plus a regenerative detector, such as the Roberts and the latest model of the Browning-Drake. The result is accurate, despite its extreme simplicity.

Place your neutralizing condenser at zero, *i. e.*, so that its capacity is at minimum value, and turn your feedback coil or feedback condenser until the detector breaks into oscillation. Under these conditions, when you touch the antenna post with the wetted finger tip, you will hear a loud click in the phones or the loud speaker.

Increase the neutralizing condenser capacity and the loudness of the plop will gradually diminish and reach a state where it leaves only the faintest click.

This is the state of the most perfect neutralization.

You can perform this process with your antenna connected.

Kiyosi Kawahara,
Hukuwoka, Japan.

THE quarterly $25 dollar prize award for the best idea submitted to this department during that period, is this time awarded to W. B. Harrison, whose idea was printed in the July Radio Broadcast. *Particulars of this award appear at the top of page 338*

THE BEST IN CURRENT RADIO PERIODICALS

The Tenth Installment of a Useful Classified Survey of Material Appearing in the Radio Press

By E. G. SHALKHAUSER

How This Survey Can Help You

HOW often have you looked for information contained in some article which you recall having read months ago—the description of the Browning-Drake receiver, or the measurement of losses in inductance coils, for example? After looking through probably several issues of a dozen different publications, you either give up or become interested in something altogether different.

When data is wanted on some particular subject, a systematic file of subjects and titles becomes a real radio encyclopedia. Instead of having merely the title of an article given, which often is misleading, a summary of the contents gives all the information. These surveys cover the radio field as gleaned from material in to-day's periodicals. They will always serve as a future reference-guide to all who are interested in the science of radio, whether engineer, manufacturer, dealer, experimenter, or listener.

To be of practical value and easily accessible, these surveys should either be pasted in a scrap book, or, better still, be pasted on individual cards and filed according to numbers, or alphabetically. In the matter of classification of articles, the Bureau of Standards circular No. 138 has been followed. This may be obtained from the Government Printing Office, Washington, District of Columbia, for ten cents. In addition, each abstract has certain key-words placed at the upper right, which may be used for the purpose of filing articles alphabetically.

With this series of surveys we hope to aid our readers and help them through many difficulties which they no doubt have often experienced. The writer is prepared to give information and references to articles previously surveyed upon receipt of a stamped and self-addressed envelope.

Following is the series of headings, made up according to the Dewey Decimal System used in the Bureau of Standards circular No. 138:

R000 RADIO COMMUNICATION IN GENERAL.
Under this heading will appear all subject matter pertaining to laws, regulations, history, publications, etc., which deal with radio in a general way.

R100 PRINCIPLES UNDERLYING RADIO COMMUNICATION.
Here will be given the phenomena of radio waves, their underlying theory of propagation, the principle of antenna and counterpoise, design and characteristics of vacuum tubes and their behavior in circuits, types of circuits, transmitting and receiving apparatus and their principles of operation.

R200 RADIO MEASUREMENTS AND STANDARDIZATION METHODS.
The various known methods which have been used in measuring frequency, wavelength, resonance, capacity, inductance, resistance current, voltage, dielectric constants, and properties of materials, will be mentioned here.

R300 RADIO APPARATUS AND EQUIPMENT.
A description of various types of antennas and their properties, the use of the electron tube in various types of receiving and transmitting sets, other methods of transmission of signals, various detecting devices used in reception, instruments, and parts of circuits, come under this heading.

R400 RADIO COMMUNICATION SYSTEMS.
The spark, modulated wave and continuous wave systems in transmission, beat and other methods of reception, wired wireless, automatic printing, the buzzerphone and Fullerphone, will be given here.

R500 APPLICATIONS OF RADIO.
To aviation, navigation, commerce, military, private, and broadcasting, and the specific information under their headings, are referred to here.

R600 RADIO STATIONS.
The operation, equipment, and management of radio installations, both transmitting and receiving, the testing, the rules and regulations concerning stations, the reports and bulletins issued will follow under this heading.

R700 RADIO MANUFACTURING.
Data relative to costs and contracts of radio equipment from raw material to finished product, including factories, tools, equipment, management, sales and advertising, is under this head.

R800 NON-RADIO SUBJECTS.
The matter of patents in general; the mathematics and physics, including chemistry, geology, and geography; meters of various kinds; all information not strictly pertaining to radio, but correlated to this subject, will be found under this heading.

R900 MISCELLANEOUS MATERIAL.

A Key to Recent Radio Articles

R113. TRANSMISSION PHENOMENA — "SINGLE SIDE BAND" TRANSMISSION.
RADIO BROADCAST. June, 1926, pp. 111–115.
"How New York Talks to London," E. H. Felix.
A new telephone transmitting station of 150-kw. power has been installed at Rocky Point, Long Island, utilizing the "single side band" system of transmission. It is claimed that this new method of energy transmission is superior to other schemes in several ways. Only one-quarter to one-sixth the power is required to transmit a given distance, only one-half the wavelength band is used, and it is less subject to fading than the double side band system used at present. The underlying principle of "single side band" transmission is explained. The new water-cooled vacuum tube forms the nucleus for this new station. Photographs and diagrams are shown.

R140. RADIO CIRCUITS. — "RADIO BROADCAST LAB." CIRCUIT.
RADIO BROADCAST. June, 1926, pp. 121–125.
"The 'RADIO BROADCAST Lab.' Circuit," K. Henney.
In experimenting with radio receiving circuits it is well to begin with the simple hookup shown, according to the writer. The bridge circuit (known as the Hull circuit), used in conjunction with the toroidal coil, is analyzed for the benefit of the experimenter. Attention is called to parasitic oscillations likely to occur at about 3748 kc. (80 meters), which can be balanced out by using a trap circuit. The correct turn ratio to use in the r.f. transformer depends upon the plate impedance of the tube used, a table of values being given. Data governing the characteristics and the operation of the circuit are presented.

R375.3. ELECTROLYTIC RECTIFIERS. — RECTIFIERS, *Electrolytic.*
Radio. May, 1926, pp. 19ff.
"Electrolytic and Mercury Arc Rectifiers," J. B. Dow.
Electrolytic rectifiers usually consist of lead and aluminum plates in either a borax solution or a neutralized solution of phosphoric acid. To form new cells, either a direct or an alternating current may be used, the latter not being as good for the purpose. The method of connecting cells to the circuit, amount of current to use in forming, and the phenomena to observe when cells are in operation, are discussed. For the various types and sizes of tubes on the market recommendations are made concerning cell dimensions and the correct number to use. The thermionic and the mercury arc rectifiers are also mentioned in this connection.

R900. PACKING RADIO SETS. PACKING RADIO SETS.
RADIO BROADCAST. June, 1926, pp. 126–127.
"How to Pack Radio Sets for Shipment," S. W. Todd.

Suggestions and information are given to those who wish to ship radio sets by express or freight. The best container to use is an air-cushioned corrugated cardboard carton. The accompanying photographs show clearly how receivers should be packed.

R386. FILTERS. WAVE-TRAPS.
RADIO BROADCAST. June, 1926, pp. 138–142.
"Cutting Out the Locals," H. E. Rhodes.

A series of tests to develop a simple wave-trap for receivers located within a few miles of high-powered broadcasting stations, are described. By the use of a simple condenser and coil arrangement, receivers can easily be made more selective. Also the sensitivity can be increased by adding an additional stage of r.f. amplification, such as the "Penetrola."

R700. MANUFACTURING. A JOB IN THE
Radio. May, 1926, pp. 8ff. RADIO FIELD.
"Breaking Into the Radio Game," H. S. Pyle.

The radio field may be divided into three main branches; manufacturing, selling, and operating, says the writer. In order to enter the manufacturing field, the prospective job-seeker is advised to enter some factory making either marine radio equipment or broadcast receivers, in order to gain his fundamental knowledge.

In the selling side of radio it is essential that you know the product you desire to sell. You may become an outside commission salesman or a counter salesman. Both branches however, require sales ability which is necessary in all selling lines. A good radio salesman must know the latest developments in radio circuits, hookups, apparatus, etc., to be a real success.

As a station operator, the applicant must have passed the government license examination for the particular type of transmitting stations he wishes to operate. These may be classified as radio broadcast stations, private stations, high-powered transoceanic stations, and ship stations. In all, a thorough knowledge of the principles of radio communication are essential.

R344.5. ALTERNATING CURRENT SUPPLY. ABC
Radio. May, 1926, pp. 13ff. ELIMINATOR.
"The Half-Wave 'ABC' Eliminator," G. M. Best.

A description of a half-wave ABC eliminator, using General Radio rectifying transformer, is given, accompanied by circuit diagrams and constructional data. A method of connecting up a Bremer-Tully "Counterphase," with filaments arranged in series, is also shown.

R381. CONDENSERS. CONDENSER
Radio. May, 1926, pp. 18ff. PRINCIPLES.
"What Constitutes a Good Variable Condenser and Why," H. M. Bishop.

The prime requisites of a good variable condenser are said to be:

(1). Low high-frequency resistance; (2). Adequate insulation; (3). Ruggedness; (4). Adjustability; (5). Compactness; (6). Smoothness of operation. These requisites are taken up in order, and discussed.

Either brass or aluminum can be used for the plates, and silver plating adds little to the efficiency. Low resistance joints are necessary. Insulating material should be so placed that it be out of the electric field as much as possible. Surface leakage should be avoided. Low eddy current losses are obtained by making plates thin and small without sacrificing strength and durability. Although this loss is of little consequence compared to the other losses, its value is greatest in solid heavy end plates.

The following are said to be good insulating materials: Hard Rubber, Bakelite, Micarta, Formica, Porcelain, Isolantite, and Pyrex. Electrical efficiency should remain paramount and not be sacrificed when design and construction are considered. This pertains to plate thickness, end plate construction, condenser bearings, rotor contact, and the method of mounting. A good condenser is usually also compact. Its maximum to minimum capacity ratio should be about 50. A higher ratio is not necessary and may result in excessive resistance.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER,
Radio. May 1926, pp. 21ff. *Short-Wave.*
"Improving 40-Meter Foreign Reception," Don C. Wallace.

The problem of extraneous noises, and the effective shielding of short-wave receivers against these noises, is discussed. The author proceeds to describe an efficient short-wave receiver to operate from 9994 to 6250 kc. (30–48 meters). Long antenna wires up to 750 feet in length have been found very effective in picking up the extremely high frequencies from foreign amateur stations.

R386. FILTERS. SUPER-HETERODYNE
Radio. May, 1926, pp. 25ff. BAND FILTER.
"A Super-Heterodyne Band Filter," R. B. Thorpe.

An electric wave filter, designed and developed by G. A. Campbell to be used in conjunction with super-heterodynes in the intermediate stage amplifying circuit, promises to make the receiver considerably more sensitive and selective without cutting away any of the desired sidebands. The constructional details of a typical filter circuit to operate at 30,000 cycles, is given.

R113.5. METEOROLOGICAL TRANSMISSION AURORA PHENOMENA. BOREALIS.
Popular Radio. May, 1926, pp. 11–18.
"Does the Aurora Borealis Affect Radio Reception?" W. D. Terrell.

Unusual electrical disturbances are probably due to a display of Northern Lights, says the writer, his statements being based on personal observations, and reports from other observers. Possibly the discharges of atmospheric electricity related to the Aurora may create electromagnetic waves of irregular type, suggests Doctor Terrell. It is known that an Aurora display affects telegraph transmission lines, setting up stray currents. All radio districts in the United States report bad blanketing effects on radio reception with the exception of the New Orleans and Florida areas. The direct cause of all of these unusual disturbances may be attributable to sun spots, and to heavy ionic and electronic discharges from the sun.

R800 (510) MATHEMATICS. FORMULA FOR
Radio. May, 1926, pp. 31ff. RECEIVERS.
"The Arithmetic of Radio," E. M. Sargent.

The various radio formulas applicable to simple radio circuits are outlined, and examples given. A two-tube regenerative circuit is shown as a typical example. Equations governing antenna current, ohmic resistance, inductance, capacity, and natural wavelength of the antenna; coefficient of coupling between primary and secondary; and wavelength and voltage induced in a secondary circuit, are discussed. The effect of connecting condensers across the primary of the transformer is shown, and the calculation of tube impedance is described.

R344.3. TRANSMITTING SETS. TRANSMITTER,
Radio. May, 1926, pp. 35ff. *15-Watt.*
"A 15-Watt Tube Transmitter," D. B. McGown.

Using a UX-210 or CX-310 vacuum tube, which has characteristics similar to the old UV-202, the writer presents a transmitting set, the construction and operation of which is described in detail. The Hartley circuit is used, the set operating on 15,000 and 7500 kc. (20 and 40 meters). A new keying system is used whereby a high positive potential, obtained from the plate-voltage source, is placed on the filament to stop the tube from oscillating. When the key is open, the tube does not oscillate, but when it is closed the potential of the filament is reduced to that of the grid, and the tube oscillates. Special arrangements are made to keep the high frequency energy out of the keying system. Compactness, and simplicity of adjustment, are advantages of the set.

R133. GENERATING ACTION. PARALLEL OPER-
Radio. May, 1926, pp. 42ff. ATION OF TUBES.
"Parallel Operation of Tubes," G. F. Lampkin.

The data presented intend to show that with a coupled Hartley oscillator circuit the output of tubes connected in parallel is proportional to the number of tubes used. The information is given in a series of curves. Curve No. 2 shows the adjustment of grid excitation for maximum output; curve No. 3 shows the grid leak adjustment for maximum output; curve No. 4 shows the relation of output to the number of tubes in parallel, curve No. 5 shows the relation of plate voltage to output; and as a comparison, curve No. 6 shows the relation of power output to number of tubes in parallel for conductive coupling. All tests were made with 5-watt Roice tubes on a frequency of 3750 kc. (80 meters).

R375. DETECTORS AND RECTIFIERS. SYNCHRONOUS
QST. May, 1926, pp. 9–16. RECTIFIERS.
"Taming the Synchronous Rectifier," R. S. Kruse.

The synchronous rectifier used in rectifying 60-cycle a.c. has its disadvantages because of the bad sparking at the contacts. Two types of rectifiers are generally used, the vibrating type and the rotary disc. To either prevent this sparking or reduce it to an absolute minimum, the author discusses several filter circuits which may be used. One of the circuits makes use of either an S tube or a kenetron rectifier. Other circuits, the so-called Hoover, the Morris, and the Indianapolis, have their advantages, and are used with great success.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER,
QST. May, 1926, pp. 23–26. *Reflexed.*
"A Reflexed Receiver with Resistance Audio Coupling," L. W. Hatry.

The problem of proper reflex circuit design is considered, and its advantages and disadvantages summarized. A four-tube resistance-coupled reflex set is illustrated and described in detail. Tubes to use, constructional hints, and results to expect, are given.

R320. ANTENNAS. ANTENNAS.
QST. May, 1926, pp. 27–29.
"Picking a Good Antenna for the Short-Wave Station," C. H. Starr.

In the writer's opinion, good results in short-wave transmission depend upon a steady note and a good antenna. A good antenna can only be discovered by making comparative measurements. The resistance of an antenna may be measured in the usual way, or the results may be compared by taking field strength measurements at many distances. The question of operating an antenna at its fundamental or at one of the harmonics is still open to discussion. A radio frequency feeder line may be used, as suggested, if the antenna is in a remote location.

R375.3. ELECTROLYTIC RECTIFIER. RECTIFIER,
QST. May, 1926, pp. 30–32. *Electrolytic.*
"A Dry Electrolytic Rectifier," R. S. Kruse.

A dry electrolytic rectifier has been placed on the market, using magnesium as one plate and a composition disc as the other. The theory of operation is not disclosed, but diagrams and a general description are given.

R113. TRANSMISSION PHENOMENA "SINGLE SIDE BAND" TRANSMISSION.
Wireless World (London). March 31, 1926, pp. 487–489.
"Single Side Band Transmission," E. K. Sandeman.

The fundamental principles of ordinary radio telephone transmission, taking up modulation, analysis of the modulated wave, complex wave forms, side bands and their detection, and a preliminary discussion of "single side band" transmission is discussed. (Continued April 7, 1926, issue pp. 529–532).

The characteristics of single 'side band transmission" and carrier suppression are summarized as follows:

(1). The frequency range occupied by the side bands is halved, the energy radiated in the side band frequencies being unaltered if the carrier is radiated as in the normal case.

(2). By suppressing the carrier, the side band amplitude may again be doubled. The net result of these changes is an improvement in noise ratio of 4–1 on a voltage basis.

(3). Since two side bands occupy half the frequency range occupied by one, it is possible to transmit each side band frequency with more nearly the same attenuation.

(4). The frequency band width occupied in the ether is one-half that occupied by the normal system of transmission, so that twice as many channels of communication are made available.

A practical method of producing a single side band, which is actually in use at the present time, is described in this article.

R343.7. ALTERNATING CURRENT SUPPLY. RAYTHEON
Popular Radio. May, 1926, pp. 19–25. POWER PACK.
"How to Build the Improved Raytheon Power-Pack," L. M. Cockaday.

Several models of power-pack units, incorporating three values of plate voltages, are illustrated and described. Blue print diagrams, circuits, and a list of parts are included in the discussion to facilitate construction.

R230. INDUCTANCE. INDUCTANCE.
Popular Radio. May, 1926, pp. 42–43.
"An Easy Method for Calculating Coil Inductance," M. M. Silver.

The equations and accompanying charts show how, with a given size of condenser, the inductance of a coil can be determined, the number of turns and the coil diameter to length ratio determining the wavelength range to which the combination will tune. Also, having coils of known dimensions, it is possible, with the aid of the charts, to determine with what size condenser they should be combined to tune over a given frequency band.

R110. RADIO WAVES. POLARIZATION OF
Radio News. May, 1926, pp. 1540ff. RADIO WAVES.
"Changes in the Polarization of Radio Waves," G. W. Pickard.

Electric waves are polarized at the source since they are produced by currents set up along fixed conductors; light waves, on the other hand, are non-polarized at the source since they are set up by electronic vibrations in all planes. It has been determined that the lower frequencies, 10–700 kilocycles, are vertically polarized, but frequencies above these values, exceeding one or two megacycles, whether radiated horizontally or vertically, are horizontally polarized.

Tests were made to determine: (1). The polarization at different distances from high-frequency transmitters radiating vertically plane polarized waves; and (2). What a comparison at both low and high frequencies from a distant transmitter, which should radiate alternately vertical and horizontal waves, would show.

Precautions must be taken when making measurements, since ground reflection may cause erroneous conclusions to be made, the author citing an example of a wave coming to the test apparatus at an angle of 45°, plane polarized. Measurements made in an isolated locality in New Hampshire, 7 meters above the earth, with a resonator wire 8 meters long, and a super-heterodyne of special construction, gave results which indicate that the above mentioned statements are correct. The chart indicates the relation existing between horizontally and vertically polarized waves at various distances and at different frequencies. The cause for the rotation of the plane of polarization of radio waves may be partially due to the earth's magnetism, says Doctor Pickard. Data are presented covering specific tests.

R330. ELECTRON TUBES. VACUUM TUBE,
Radio News. May, 1926, pp. 1546ff. *110-Volt.*
"A 110-Volt Filamentless Tube," A. N. Lucian.

A new type of vacuum tube, operating directly either from the regular 110-volt a.c. or d.c. source, or from some other heat source, is described. The writer first mentions some of the many disadvantages of the present type of filament tube and then states the advantages of his filamentless bulb. A coil heater is used to cause electrons to leave a Wehnelt oxide coated thimble, these electrons being controlled by a regular plate and grid arrangement. Diagrams and photographs illustrate the tube and its details.

R330. ELECTRON TUBES. DONLE B-6
Radio News. May, 1926, pp. 1548ff. DETECTOR.
"The New Donle B-6 Detector," H. P. Donle.

A new gas-filled detector tube, known as the Donle B-6 detector, has been developed. The tube needs no critical filament current adjustment, but is rather sensitive as to plate voltage. Its output is greater for weak signals than other tubes used for the same purpose, and therefore can be used in sets to pick up distant stations. A new gas is contained in the tube. A grid leak and condenser is not necessary. Curves showing its characteristics and points of merit are shown.

R800 (533.85). VACUUM APPARATUS. VACUUM
Radio News. May, 1926, pp. 1550ff. PUMPS
"How Radio Tubes Are Evacuated," Dr. C. B. Bazzoni (Continued from March issue)

Mercury air pumps are used in the majority of cases for obtaining high vacua. Of these, the Sprengel pattern is the simplest (described in the March issue). Three types of high speed pumps are here discussed, namely: (1). The Gaede rotary mercury pump; (2). The Langmuir mercury pump; (3). The Holweck mercury pump.

The Gaede pump is really a high speed continuously acting Sprengel pump. It will produce a vacuum of .00001 mm. pressure when backed up by another pump which can maintain the pressure below 1 cm. About 40 pounds of mercury are required to fill the pump to the proper level. Diagrams of the pump, and its operation, are discussed.

In the Langmuir mercury-jet condensation pump, a stream of high speed mercury molecules is used to drive out the air molecules from a chamber connected to the bulb. Unlike the Gaede pump, in which evacuation depends on successive expansion of the air in the container, the condensation pump depends for its efficiency on the rapidity and completeness of the condensation of the mercury vapor on the walls of the inner vessel. To prevent mercury and water vapor from getting into the bulb being evacuated, liquid air is used in freezing these vapors out. A pressure as low as .000001 mm. of mercury has been obtained. The molecular pump, although very effective, is expensive due to the fact that it must be made exceedingly accurate. The principle of operation depends on the high speed of the drum within the pump, which gives the air molecules motion in a definite direction. A forepump of .001 mm. pressure is required. Designs of the Holweck pattern pumps are shown.

In commercial work, not much time can be spent in obtaining high vacua, and for that reason substances like phosphorus, arsenic, sulphur, iodine, are introduced into the vessel, these acting as "getters." The vapor of these substances collects on the surface of the glass and in some way covers up the left-over gases within a short time after the filament of the tube has been burnt. In the laboratory, charcoal is used for the purpose of absorbing gases, when cooled with liquid air.

BOOK REVIEW

A Primer for the Tyro Who Wishes to "Hear" Music

EVERYBODY'S GUIDE TO RADIO MUSIC. *By Percy A. Scholes. Published by the Oxford University Press, American Branch, New York. 204 pages. $2.*

THIS book, "Everybody's Guide to Radio Music," is our familiar friend the music appreciation primer dressed up in the plus-fours and perforated oxfords of the radio age. But the fact that the material is handled from the radio listener's point of view should make it considerably easier to take. The occasional references to radio serve as a friendly buoy to which the neophyte can cling trustingly from time to time before venturing into the terrifying sea of musical fact.

It is a book that no radio fan who wishes to get the maximum enjoyment out of his receiving set can afford to be without. The author, Percy A. Scholes, is an outstanding authority on music, and has written numerous volumes on the subject. Moreover, he occupies the position of music critic to the British Broadcasting Company. "This," he says in preface, "brought me hundreds of letters—friendly, inimical, dogmatic, inquiring. I can claim, then, to understand something about the mind of the listener to broadcast music, and if I fail to provide what that mind demands or requires, it will be my own fault."

Some idea of the contents of the volume can be gained from a random selection of chapter headings, among them: "What Is Music?"; "The 'Form' of Music"; "How to Listen to an Orchestra"; "A Chapter on Songs"; "What is Good Singing?"; "The Two Qualities of Music—Good and Bad"; "Is Modern Music Any Good?"; "What Will Broadcasting Do for Music?"

We have often wondered why that most powerful incentive "curiosity" has not been more of a factor in promulgating a knowledge of music. The individual who hears music with his ears only—and his number is legion—is constantly being told that there is something in music to which he is totally oblivious; that there is a pleasure to be derived from music which he has never experienced and the nature of which he has never for an instant conceived.

Unless he chooses to believe that all such talk is simply part of a gigantic hoax, we fail to see why his curiosity is not vastly excited. For instance, Messrs A and B listen to the same symphony. Mr. A kens music. Mr. B does not. Mr. A has a good time. Mr. B is bored. Mr. A, being impolitely frank, tells B "Of course you were bored, you didn't hear the symphony!" Now Mr. B knows that his ears were as wide open as those of his more erudite companion; unless he secretely concludes that A is a *poseur*, we should think he would be enormously curious to know what in the world there was in that collection of sounds that A heard and he did not.

The language of music is so completely different from the language of any other of the arts that it is almost imperative that outside help be engaged for the elementary lessons. Once started, it may be possible to continue alone. Such tutelage may be gained in either of two ways—by the personal assistance of some music loving acquaintance, or by perusal of a book on the subject.

It is for just this purpose that "Everybody's Guide to Radio Music" was designed. It is written in a breezy style, with a thorough omission of technical jargon. Its aim is to conduct the willing reader gently by the hand and initiate him painlessly into the mystery of music. And

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music is a mystery, a baffling one, until it is once comprehended, when it becomes all very simple.

In his effort to make the book informal, Mr. Scholes has succeeded too well, and has sacrificed continuity and proper balance of material. It is a collection of miscellaneous chapters rather than a progressively developed unit. But this makes for easy reading as the volume may be picked up and begun anywhere.

An instance of the lack of balance is the far too great space devoted to opera. He gives it thirty pages and includes a lengthy catalogue of libretti. One of the most startling of contemporary phenomena is the absurdly inflated esteem that is accorded opera. The word is printed in large capitals and mentioned in reverent whispers as though it were the highest, greatest, and most noble manifestation of music. As a matter of fact, it is probably the lowest, and should occupy a niche only slightly above the cabaret song. There are good operas, but they are the ones that are never performed, or, if ever, only once or twice a season, and then to meager houses. We are of the opinion that a good opera would make very poor radio material; for, if it is truly good, the action and scenery is so wedded to the music and words as to be essential to a proper enjoyment. However, the operas that are regularly broadcast are probably improved by being shorn of their silly mummery. Mr. Scholes defends opera broadcasting on the ground that before long we shall have the action as well as the sound transmitted.

We should have liked to have seen Mr. Scholes devote more space to pounding in the fact that music is a self contained art. For it is ignorance of this fact that constitutes the most serious stumbling block to the would-be connoisseur. It is true of all the arts that this conception of "uniqueness" is the first barrier to be surmounted if further progress is to be made. While superficially the arts may seem to overlap, they are in their purest elements absolutely distinct. The masterpiece, in any one of the arts, is that work that most fully develops the possibilities of its own particular medium, and borrows the least from other mediums. Thus to say that a painting has sculptural or musical or poetical values, is to damn it far more than to praise it.

The book takes up the various instruments of the orchestra and describes and illustrates each. There is an easily intelligible discussion of the "form" of music, and several chapters that aim to provide the reader with some standards of intelligent criticism. The devotee of jazz—good jazz—need have no fear that Mr. Scholes is going to deride him. Says the author, "If the cabaret song and the symphony are both good, then I am in favor of both. But if they are both bad, then I am against them both."

As successive subjects come up for discussion, the reader is referred to various books, all accessible in the public libraries, which discuss the subject at hand more fully. This greatly enhances the value of "Everybody's Guide to Radio Music," which, in its brevity and simplicity, makes no pretension to be more than an introduction to further study. And a stimulating and entertaining introduction it is.

John Wallace.

THE following books published by Radio Broadcast, Garden City, New York, are obtainable at $1.00 each:

"Radio Broadcast's Knock-out Four-Tube Roberts Receiver."

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"How Radio Receivers Work," by Walter Van B. Roberts.

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Radio Shows for 1926

THE list printed below, of radio shows and conventions scheduled to take place this year, has been compiled with the aid of information supplied through the courtesy of *The Radio Dealer*. Full information concerning the various shows may be obtained by addressing the secretaries, whose names and addresses are included in the list.

AKRON, OHIO

SEPT. 15-18. Akron Radio Show. Auspices Radio Dealers Association and *Times-Press*. George Missig, Secretary, *Times-Press*, Akron, Ohio.

BOSTON, MASSACHUSETTS

SEPT. 27-OCT. 2. Boston Radio Exposition, Mechanics Building. Shelden Fairbanks, Manager, 209 Massachusetts Avenue, Boston, Massachusetts.

BROOKLYN, NEW YORK

OCT. 30-NOV. 6. Third annual Brooklyn Radio Exposition, 23rd Regiment Armory. Stephen T. Rogers, Managing Director. Suite 513, Albee Building, Brooklyn, New York.

CHICAGO, ILLINOIS

SEPT. 27-OCT. 2. Second Allied Radio Congress and National Radio Exposition, Exhibition Hall, Hotel Sherman, Chicago. Milo E. Westbrooke, Manager, 440 South Dearborn Street, Chicago, Illinois.

OCT. 11-17. Fifth Annual Chicago Radio Show, Coliseum. Radio Manufacturers Show Association 127 North Dearborn Street, Chicago, Illinois.

CLEVELAND, OHIO

SEPT. 20-26. Cleveland Radio Industries Exposition. Public Auditorium. George B. Bodenhoff, Manager, 511 Guarantee Title Building, Cleveland, Ohio.

DETROIT, MICHIGAN

OCT. 25-31. Detroit Radio Show, Convention Hall. Auspices Radio Trade Association of Michigan. A. M. Edwards, Secretary, 4464 Cass Avenue, Detroit, Michigan.

INDIANAPOLIS, INDIANA

OCT. 25-30. Second Annual Indianapolis Radio Exposition, State Fair Grounds. Auspices Broadcast Listeners' Association. A. J. Allen, Secretary, 1406 Merchants' Bank Building, Indianapolis, Indiana.

LOS ANGELES, CALIFORNIA

SEPT. 5-11. Los Angeles Radio Exposition, Ambassador Auditorium, Auspices Radio Trades Association of Southern California. A. G. Farquharson, Secretary, 515 Commercial Exchange Building, Los Angeles, California.

MILWAUKEE, WISCONSIN

SEPT. 25-29. Fourth Wisconsin Radio Exposition and Convention, Auditorium, Milwaukee. N. C. Beerend, Manager, P. O. Box 1005, Milwaukee, Wisconsin.

MINNEAPOLIS, MINNESOTA

SEPT. 27-OCT. 2. Northwest Radio Exposition, Kenwood Armory and Coliseum, Minneapolis. Harry H. Cory, Executive Secretary, 301 Tribune Annex, Minneapolis, Minnesota.

NEW YORK CITY, NEW YORK

SEPT. 13-18. Third Annual Radio World's Fair, New Madison Square Garden, New York City. Radio Manufacturers' Show Association, 611 Times Building, New York City.

PITTSBURGH, PENNSYLVANIA

OCT. 4-9. Pittsburgh Radio Show. James A. Simpson, Managing Director, 420 Bessemer Building. Pittsburgh, Pennsylvania.

PORTLAND, OREGON

SEPT. 20-25. Pacific Northwest Radio Exposition, Public Auditorium. George J. Thompson, Jr., Secretary, 411 Journal Building, Portland, Oregon.

ROCHESTER, NEW YORK

OCT. 11-16. Rochester Radio Show, Convention Hall. Auspices Rochester Radio Dealers Association, Rochester, New York.

ST. LOUIS, MISSOURI

OCT. 18-23. Second Southwest National Radio Show, New Coliseum, St. Louis. Auspices St. Louis Radio Trades Association. William P. Mackle, Executive Secretary, 1207 Syndicate Trust Building. St. Louis, Missouri.

SAN FRANCISCO, CALIFORNIA

AUG. 21-28. Pacific Radio Exposition, Civic Auditorium, San Francisco. Pacific Radio Trade Association, 905 Mission Street, San Francisco, California.

SIOUX FALLS, SOUTH DAKOTA

OCT. 26-29. Sioux Falls Radio Show, Coliseum. Auspices Civic Club. Roger S. Brown, Secretary, Sioux Falls, South Dakota.

Canadian Trade Shows

MONTREAL, QUEBEC

OCT. 4-9. Montreal Radio Show, Windsor Hotel. Auspices Canadian Exhibition Co., 204 East King Street, Toronto, Canada.

TORONTO, ONTARIO

OCT. 25-30. Toronto Radio Show, Coliseum, Canadian National Exhibition Grounds. Auspices Canadian Exhibition Co., 204 East King Street, Toronto, Canada.

WINNIPEG, MANITOBA

SEPT. 13-18. Winnipeg Radio Show, Royal Alexandria Hotel. Auspices Canadian Exhibition Co., 204 King Street, East, Toronto, Canada.

Conventions

DETROIT, MICHIGAN

OCT. 25-31. State Radio Dealer Convention. Auspices Radio Trade Association of Michigan, Convention Hall, Detroit. A. M. Edwards, Secretary, 4464 Cass Avenue, Detroit, Michigan.

MILWAUKEE, WISCONSIN

SEPT. 27-28. Wisconsin Radio Trade convention, Auditorium, Milwaukee. N. C. Beerend, Manager, P. O. Box 1005, Milwaukee, Wisconsin.

ST. LOUIS, MISSOURI

OCT. 18-23. Jobbers and Dealers Convention. Southwestern states. Auspices St. Louis Radio Trades Association. William P. Mackle, Executive, Secretary, 1207 Syndicate Trust Building, St. Louis, Missouri.

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IMPOSSIBLE!

SUCH, probably, would be your reply to neighbor Smith, were he, on the morrow, to challange you with a hearty "Old man—I bagged sixteen stations in three minutes last night."

"The 'ARISTOCRAT'," he replies to your natural inquiry.

"But—"

"A single control affair," he adds, hardly giving you a chance to get a word in edgeways. "Pulls 'em in like hot cakes, and quality, oh boy!

We hardly care to chronicle Smith's remarks, so colloquial does he wax in his enthusiasm, as he relates how his "ARISTOCRAT" brings in "Animal Crackers," "Gimme a Little Kiss, Willya, Huh?," "Valencia," etc., at least six times as loud as Jones is able to bring in Rimsky Korsakov's "Scheherazade" on his eight-tube super.

When the "ARISTOCRAT" was first described in RADIO BROADCAST, some 150 newspapers all over the country published the circuit diagram with constructional details, in their editorial columns. Smith was no doubt one of the many who became interested in the description of this receiver as presented in his local *Gazette*, but, lacking the necessary technical knowledge to build the receiver from the schematic diagram, he was delighted to learn that blue prints of this receiver were obtainable from RADIO BROADCAST for $1.00 the set of three exceptionally large ones. So explicit are these blue prints that even the veriest of potential radio set constructors need not fear meeting with trouble in constructing the "ARISTOCRAT" from them. Technical knowledge is not at all necessary if you wish to build this receiver.

The "ARISTOCRAT" is a five-tube receiver which is tuned by one main control and consists of one stage of tuned, neutralized radio frequency amplification, a regenerative detector, and three stages of resistance-coupled audio frequency amplification. It is the very latest edition of the famous "Knockout" receiver which is still enjoying universal popularity. Due to the neutralized feature the "ARISTOCRAT" will not radiate and interfere with your neighbor's reception, and is remarkably selective. During an actual test, sixteen different broadcasting stations were received within three minutes by turning a single dial.

Send $1 for blueprints and interesting booklet to Booklet Dept. RADIO BROADCAST, Garden City, N. Y.

SERVICES

The Laboratory Service of RADIO BROADCAST can help you. When writing for technical information or in relation to our set repair service, please use the proper coupon below.

REPAIR SERVICE BLANK

Repair and Service Department
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

I am enclosing with this blank, a letter to the Repair and Service Department, RADIO BROADCAST Laboratory. I am not forwarding my receiver at this time but I desire to submit a receiver, which is a.......................................
described in RADIO BROADCAST, for............

- ☐ Repair
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- ☐ ....

Name.....................................

Address.....................................

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

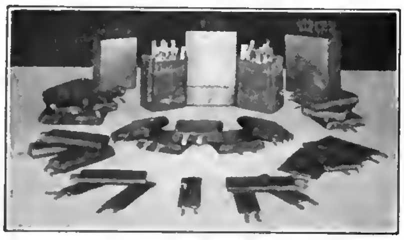
Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

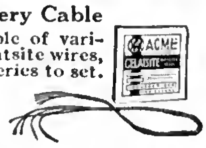
☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name.....................................

Address.....................................





WHAT OUR READERS WRITE

The Naval Research Laboratory Replies to Professor Morecroft

IN THE June RADIO BROADCAST, Professor Morecroft remarked upon certain newspaper articles which purported to have resulted from an interview with Dr. H. C. Hayes, of the Naval Research Laboratory, and which claimed for the Naval Laboratory the invention of the transmission of ultra-audible sound waves through water. Professor Morecroft wrote as follows: ". . . During the war, a group of scientists, principally from Columbia University, was assigned the problem of ultra-audible sound, and in the Navy files are complete accounts of all the properties now hailed as inventions of the Naval Research Laboratory. Those scientists were sworn to secrecy by the Naval authorities on all the work they had done, or the scientific journals would have received authentic reports of this fascinating branch of acoustics." Here is a letter from Doctor Hayes in reply:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

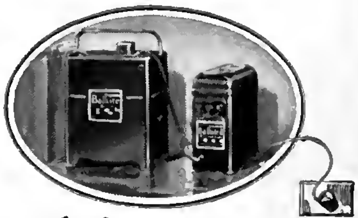
The article "Something about Supersonics," published in the June number of RADIO BROADCAST, calls for reply out of fairness to the Naval Research Laboratory and its staff. Had it been written by a newspaper reporter as a result of an interview with Professor Morecroft, we should know that its statements contain more of fancy than of fact, and would reserve our comment.

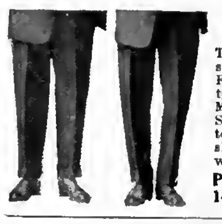
We have not seen the newspaper articles in question but are willing to believe they are typical, in that the reporter has used the facts given to him as a basis for a "story" which makes the scientist interviewed the hero and which is discolored and distorted by the writer's imagination so as to give a false impression, if indeed, it gives any clear and definite impression at all. We will say in defense that the interview which led to these news articles was granted contrary to our recommendations, and the reporters were only given certain general facts that were already somewhat widely known. We stated clearly that other scientists in England, France, and the United States had helped to develop the subject during the past ten years, but we scrupulously avoided crediting individuals, ourselves included, for fear that someone might be slighted or wholly overlooked.

We, too, are sworn to secrecy, and we made an honest effort to tell the reporters nothing of value and to do this in a way that would not be unfair to others. We did not write the articles or have an opportunity to correct them before they were published. If they convey the impression that we claim the whole or any major part of the credit for developing the "supersonics," they do so without our consent. We do not make such claims and never have.

We know that most of the credit for developing the supersonics should, and eventually will, go to foreign scientists, and we are convinced that Professor Morecroft knows this as well as we do. It is, therefore, inconsistent, to say the least, that he should criticize us for assuming such credit and in the next paragraph claim this credit for the Columbia University scientists "principally."

Very truly yours,
H. C. HAYES,
Physicist, U. S. N.,
Naval Research Laboratory.





To Roberts Knockout Fans

Do you know that we have published two books on the Roberts Knockout Receivers? One is a treatise containing all the articles printed, and the other is just one article with complete blue prints on how to build this wonderful receiver. Price one dollar each. Write to Booklet Dept., Radio Broadcast, Garden City, N. Y.

RADIO BROADCAST

WILLIS K. WING, Editor

SEPTEMBER, 1926 — Vol. IX, No. 5

KEITH HENNEY, Director of the Laboratory

JOHN B. BRENNAN, Technical Editor

CONTENTS

BEHIND EDITORIAL SCENES

THE list of the contents of this magazine, directly to your left, contains, we believe, an extraordinary variety of radio information, and a group of articles as good as has ever assembled in a radio magazine. Austin Lescarboura's article on "How Much It Costs to Broadcast" gives some news on the cost of broadcasting which the listener has never had available before. Mr. Bouck, a favorite writer with the readers of RADIO BROADCAST, old and new, announces a new system of radio frequency control, made available for the first time to the home constructor. We believe the possibilities of the King Equamatic system are quite large. More will be printed on this interesting subject. . . . Interest in super-heterodynes is by no means dead, and we feel that since so many of our readers are owners of these sets, of one model or another, the article by Kendall Clough containing, as it does, so much genuinely authoritative information on the operation of those circuits, will be of utmost help to the many owners of "super-hets."

FRANK C. JONES'S short-wave prize contest set, should provide a means of entry into the ranks of short-wave experimenting, and, to amateurs who are already familiar with receiving on such frequencies, a set which will give them a circuit suggestion which is extremely inspiring . . . John B. Brennan, our technical editor, has prepared one of the most complete constructional articles it has been our privelege to present, on the Browning-Drake circuit, using impedance-coupled amplification. This model, while it features unusual standards of high quality amplification, sensitivity, and selectivity, has the predominant merit of being a beautiful constructional job. . . . The paper by Alfred W. Saunders, delivered before a recent meeting of the Radio Club of America, contains some most interesting information on transformer amplification.

RADIO BROADCAST for October will be one of the most interesting numbers ever presented to our readers. It will be the special Metropolitan Shows Number and will contain sixteen pages of extra text devoted to the news of the radio shows of the fall season. The new products of the manufacturers will be completely described and illustrated, and there will be some additional special features of unusual interest to everyone who gives a thought to radio. . . . There have been dismal howls for some time now about monopoly in radio and other indefinite awful things to happen in radio. RADIO BROADCAST has commissioned French Strother, one of the ablest special writers in the country, and the best we could find, to study the entire question of what is to become of radio in the United States. The first of his fundamental and highly important articles will be a feature of this magazine for October. Also there will be descriptions of several excellent receivers and a real wealth of radio information which will make the reading of RADIO BROADCAST essential to all well informed radio folk.

—WILLIS K. WING.

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Research is an important part of RCA business. In transoceanic wireless—and in the tiniest detail of vacuum tube making—RCA continually offers the world new developments in radio. Be sure *all* your tubes are genuine RCA Radiotrons! And keep a spare handy.

RCA

RADIO CORPORATION OF AMERICA
NEW YORK CHICAGO SAN FRANCISCO

RCA Radiotron

MADE BY THE MAKERS OF THE RADIOLA

THE RADIO-CONTROLLED FOG SIGNAL AT THE ENTRANCE, FIRTH OF CLYDE

This Scottish fog signal is said to be the only radio-operated signal in existence. A transmitter on shore, a mile and a quarter away is used to send out a special signal which starts or stops the fog "gun". The starting and stopping radio signals are of different frequencies. The receiver comprises a two-tube unit for detecting and amplifying the incoming signals, and a two-tube unit for operating a moving coil relay. The receiver is entirely self-contained and needs attention only once in three months for battery recharging and tube replacement

RADIO BROADCAST

VOLUME IX NUMBER 5

SEPTEMBER, 1926

How Much It Costs to Broadcast

The Good-Will Program Is Solving the Problem of Who Is to Pay for Broadcasting—In 1921 and 1926—Looking at Programs from the Other Side of the Microphone

By AUSTIN C. LESCARBOURA

IT WAS a most pleasant evening after all. True, the trip to Newark, on the other side of the renowned Jersey Meadows, was somewhat tiresome for one residing up and across the Hudson River. Yet, to compensate for all that, I was met at the Tube Terminal by a private limousine, swiftly borne to the best hotel, entertained and dined by the cordial staff of mine host, motored to the broadcasting station located in a corner of a vast factory building, and introduced to an invisible audience with much flourish of vocal trumpets. The thing addressed seemed like nothing so much as a tomato can dangling from an adjustable support. I was given all the time in the world to say what I had to say—there was nothing else to fill out the allotted time of the station that evening except the hard working automatic piano—and then complimented, given an opportunity of calling my home and various friends to learn how my voice had gone over, offered refreshments, and then conveyed in regal state back to the Tube Terminal amid a shower of thanks. The next day, and for several days thereafter, I was veritably deluged with letters, telephone calls, telegrams, and personal calls, congratulating me on my radio talk and urging me to go before the microphone again at an early date!

And now, as the novelists say, six years have elapsed since the foregoing-mentioned experience, which took place late in 1921, when broadcasting was in its very infancy.

Once more I feel a radio talk coming on, and so I hasten to one of the largest local broadcasting stations to seek a place on the air. I am met by a bright young lady—the assistant program director, so I am told. I state my purpose. She smiles pleasantly despite her serious tortoise shell glasses. "It's a very good subject," she says, "and well worth putting on the air. Now let's see, we could book you for September 15th, just about nine weeks away at 11:25 in the morning, between the Mixum Soup Kiddies feature and Professor Bedingus's talk on the food values in noodles. Or if you prefer the afternoon, we have an opening still left in our October schedule—yes, here it is, October 23rd, at 3:15. If you prefer the evening, we have an opening still left in our January schedule, yes, January 17th, at 7:15. No doubt you already know our rates, but here is a rate card and our short form contract. You will note, the morning talk is $100.00 for ten minutes. The afternoon talk is $150 for ten minutes. The evening talk is $200 for ten minutes. Of course we must have a copy of your speech a week in advance. What's that? Do we pay you for the talk? Oh, you jollier! No indeed, you pay us for the privilege of speaking to our invisible audience. But getting back to all seriousness, I may put you down for——?"

The conversation terminated then and there.

"GOOD WILL FEATURES"

The "Happiness Boys," Billy Jones and Ernest Hare, who are heard from WEAF "every Friday night at eight." These two excellent popular singers have been a feature of an indirect advertising program with this station for a long time and are an excellent example of well presented, frank advertising

We simply fled from the palatial studio office and sought solace in the big crowds milling about the busiest thoroughfare of Old Gotham, gradually regaining our normal senses once more.

That experience, however, aroused our curiosity. Was this station typical of the policy now pursued by the five hundred or so other stations scattered from one end of the country to the other? That we determined to find out at first hand; and accordingly, we launched into an extensive investigation of the broadcasting situation, addressing questionnaires to large and small stations alike, calling in person on many broadcasting directors, and listening-in on the programs of stations both near and far. All of which has resulted in a vast fund of information which, boiled down, predigested, and seasoned with personal opinions and deductions, constitutes the following essay.

BROADCASTING IS PAYING ITS OWN WAY

THE sum total of the survey is simply this; broadcasters have found a ready means out of their economic difficulties. Broadcasting is no longer a free service. While it may seem quite bizarre for twenty-five to thirty million persons to be served royally in their homes, day in and day out, with a procession of entertainment such as would make even old King Solomon turn green with envy, there is nevertheless nothing free about it. Someone is footing the bill in order to place certain ideas before the public in their very homes, while the public, in turn, is expected to repay for the programs by patronizing certain products in preference to all others. Broadcasters, in the main, have ceased to be philanthropists and, if anything, are fast becoming prosperous purveyors of sugar coated publicity served in a most palatable style at the home fireside. Perhaps no better proof of all this is to be found than in the fact that six hundred or more applications are pending for broadcast licenses. They are likely to be pending for a long while, since the air is already crowded with the voices of well over 500 broadcasters. And when have we

IN MARCH, 1925, Radio Broadcast *awarded a prize of $500 for the best answer to the question, "Who is to Pay for Broadcasting?". The winning plan provided for an indirect tax on the listener administered by the Government. But it was not genuinely practical because listeners feel, rightly or wrongly, that when they buy their equipment, their obligation to pay for anything is ended. The broadcasters were wondering about it all, too, but while speculation was rife, they quietly realized that they had something immensely valuable to sell, and that was their audience. They are selling it, and so wisely is "time on the air" being vended that not a complaint does one hear from listeners.* Radio Broadcast *commissioned Mr. Lescarboura, formerly managing editor of the* Scientific American, *to find out what broadcasters were charging for their time and how commercialism was working with station and listener. This interesting article is the result. Facts gathered from every station in the United States are the basis for this story, which is, as far as we know, the first authoritative presentation of how broadcasting is paying for itself.*—The Editor.

heard of a waiting list for a philanthropical service!

Rising costs and strenuous competition have been responsible for the advent of commercialism in broadcasting. It costs plenty of money to keep the air filled with programs, especially on a daily basis. Figures? Well, there is a leading broadcasting station, covering a large section of the country, which operates at a *monthly* cost of close to $30,000, including the bills of the musicians, staff, electric service, and plant. Multiply that by twelve and you have $360,000 for the year! A department store, operating a powerful broadcasting station, estimates its *yearly* operating costs at close on to $60,000! Even the modest broadcasting station, of limited power and mediocre programs, must cost upward of $25,000 a year. And then there is the heavy investment for the equipment which may run anywhere from $10,000 to a $1,000,000 or more for the latest high-power stations, at a rate of obsolescence which is positively appalling.

Little wonder, therefore, that broadcasters, realizing the futility of collecting funds from the radio audience, despite several pleas at spasmodic intervals in the past, have sought to solve their economic problem by collecting at the microphone end. At first it was the general belief that the operating expenses of broadcasting stations could be derived from the sale of radio equipment, but unfortunately, no manufacturer and not even a group of manufacturers could afford to broadcast throughout the entire country day in and day out in return for the sale of radio receivers and radio accessories. Existing receivers, some of them several years old, have long since received their quota of broadcasting many times over. The situation is quite like that which would result if automobile manufacturers sold their cars at the usual prices, and then offered to build more and more roads and maintain them in the best condition as a perpetual obligation to the purchasers. But automobile manufacturers make no promises regarding roads and do not support the cost of the roads. Others pay for the roads. And so with broadcasting; others pay for the programs, so that the public may ride the air waves.

YOU CAN'T ORDER 'EM TO BUY—ON THE AIR

NOW, the regulations of the Department of Commerce, as applied to radio broadcasting, prohibit direct advertising of any kind. However, genteel publicity is by no means prohibited, hence we have many shades of publicity, ranging all the way from the mere sponsoring of an excellent musical program, to that very naked publicity talk which borders so close on direct advertising that a jury must be sworn in to pass upon the evidence, while a judge must interpret the findings and render a final verdict. In fact, it may be said that advertising is not advertising when it is broadcast, for it now becomes "good will publicity!" A very flexible term, that! It seems to cover a multitude of sins.

Good will publicity, as interpreted by the leading broadcasting stations of the country, is by no means objectionable to the public, even to those who abhor that very necessary phase of modern commerce called advertising. Thus, good will publicity takes the form of excellent musical programs, rendered by highly paid musicians, preceded and followed by announcements to the effect that they are sponsored by such-and-such firm, who are the manufacturers of such-and-such product. Sometimes the announcement is worded in some other manner, such as "through the courtesy of"; but in any event, the public is told in no uncertain terms who is footing the bill and to whom it is obligated.

An analysis of the broadcasting stations of the country indicates seven broad classifications, according to their avowed purpose:

(1) Commercial or toll broadcasting stations, which are in business to make such money out of broadcasting as there is to be made. (2) Individual publicity stations, operated by department stores, newspapers, radio companies, and other commercial institutions for the purpose of building good will for the owner, but not accepting outside pay for broadcasting. (3) Educational broadcasting stations, operated by colleges and schools as a means of extension study and lectures to the radio audience. (4) Agricultural broadcasting stations, operated by agricultural colleges and other institutions for the purpose of disseminating agricultural talks, crop reports, weather forecasts and so on, to rural audiences. (5) Religious broadcasting stations, operated by churches and religious societies and organizations for the purpose of spreading religious ideas. (6) Private broadcasting stations operated by individuals for the sheer pleasure of broadcasting. (7) Experimental broadcasting stations, the purpose of which is self-explanatory. (8) Governmental broadcasting stations, operated by Federal, State, or municipal government for the purpose of providing citizens with civic information, police reports, local entertainment and so on.

Despite the divergent purposes of these eight classifications, they have one point in common: they are all bent on selling something, whether it be a product or a religion, agricultural idea or interest in economics, better voice transmission or the name of the owner. All broadcasting stations are operated for pay, but it is just a question as to who foots the bill. In some instances, the owner of the station assumes the burden of the cost; in others, the owner leases part of his broadcast facilities in return for pay with which to support the operating and maintenance cost, as well as the cost of suitable program features.

Broadcasters are not entirely agreed upon the matter of who is to pay for their services. Some broadcasters deride the idea of paid programs or sponsored features. Others are keenly in favor of paid programs. Yet, if we read between the lines, we note that it is simply a matter of whether the owner of the station derives sufficient publicity value or educational value from the broadcasting to foot the bill himself, or whether he must go out and get help from others not only to foot the bill but also to fill his programs with worthy material. One thing is certain; the sponsored program is the solution of the old, old question, "Who is to pay for broadcasting?"

HOW COMMERICAL PROGRAMS REACH A PART OF THE NATION

Many well established commercial "courtesy programs" are broadcast, originating from WEAF, in New York, and furnished to the broadcasting stations indicated on this outline map. Officials of WEAF assert that these programs reach 52.2 per cent. of the population of the United States. The chart shows the main telephone "repeater stations" through which the telephone lines pass. The programs are stepped up in volume before delivery to the tubes at each distant broadcasting station

HOW PROFESSIONAL PROGRAMS CAME TO RADIO

SPONSORED programs provide the best professional talent, since there is money available to attract such talent. No

RADIO BROADCAST Photograph

THE CORRESPONDENCE DEPARTMENT OF WEAF

At this station, from 2000 to 3000 letters are received daily and sorted into the following groups: departmental, addressed to client, addressed to artist, addressed to WEAF. The first three groups are forwarded unopened, the fourth being opened, analyzed, and charted and excerpts made for the commercial client. Every letter is carefully read and the suggestions and praise noticed

longer is the broadcaster obliged to beg, coax, and promise the world to singers and musicians. Also, no longer need the broadcasting studio be an amateur theatrical proposition, with a never-ending procession of well-meaning amateurs whose musical efforts are a severe strain upon the nerves of the radio listeners.

ANNOUNCERS WHO ARE KNOWN TO HALF THE COUNTRY

Graham McNamee, right, and Phillips Carlin. Mr. McNamee usually announces the Eveready Hour, broadcast by WEAF and many other stations every Tuesday at nine P.M., eastern time. Mr. Carlin officiates during the Silvertown hour. These two excellent announcers have probably given the necessary details for more of the conventional commercial programs than any other two announcers in the country

The transition from amateur programs to professional programs has been so gradual that radio audiences have failed to realize the vast change that has taken place in the services of the leading broadcasting stations. Yet to-day, the typical leading stations have mostly professional talent appearing before their microphones, with just a sprinkling of carefully selected amateur talent. In fact, to be permitted to appear before the microphone of a good station is as much as an endorsement of one's musical ability, these days. And the advent of professional talent on the programs of the leading stations has caused those stations to command more and more attention from the radio audience, with the result that the amateur efforts of the smaller stations are becoming increasingly neglected. If, indeed, broadcasting is a question of the survival of the fittest, the professional programs of the leading stations, as contrasted with the amateur and crude programs of most of the smaller stations, will be the determining factor, although the writer is of the opinion that there will always be room for both extremes, just as in everything else.

It is reported that the typical leading stations have 80 per cent. of their programs devoted to good will publicity features—paid features, in other words. Yet no direct advertising is permitted. The broadcasters are not permitted to quote prices or anything of a definite advertising nature. Short talks are permitted, but these must be of an exceptionally interesting nature, with only a very general bearing on the business of he who foots the bill. Often the only tie-up is in the title of the speaker and the general trend of his talk. Such talks are limited to 15 minutes at the most. Experience has proved that longer talks will not hold the average radio listener. Of prime importance is the fact that the radio listener has a wide choice of radio programs at his disposal, and the mere flip of a dial will shut off any undesirable matter. Not only is this fact of importance to the sponsor of a given program feature, but also to the station itself, since that station must cultivate a steady audience if it is going to maintain its position in broadcasting. The situation is quite analogous to the publishing business, where circulation is one of the supreme tests of goodness.

So it is that the sponsored musical program is to be preferred to talks. In the case of the leading broadcasting stations, the musical features must be of the very best. The announcements give just a brief mention of the sponsor and the sponsor's product. Sometimes, and quite effectively, the musical programs are identified with the sponsor and the product by an ingenious play of names. Again, the nature of the musical programs may have a special bearing on the product. All of which is quite obvious to all who listen-in to the present-day offerings.

BROADCASTING COSTS MONEY

NOW, there are two factors involved in good will publicity programs; first, the musical feature itself; secondly, the time or space on the broadcast program. In the case of commercial or toll broadcasting stations, the client is expected to pay for the musical feature in the first place, and pay again for the allotted time on the broadcast program. On the other hand, there are leading broadcasting stations to-day which do not charge for the allotted time but insist on the very finest musical features being supplied by those seeking good-will publicity.

"What, a female quartette!" exclaimed the program director over the telephone, while we were sitting in his office. "Nothing doing! You will have to put on at least a seven-piece orchestra that night, if you want to get in on our program. It wouldn't be fair to our other clients. No sir! Nothing doing on that female quartette! If you wish, I can fix you up with a good male quartette—that always pulls well with our audience. But that will have to be on a regular schedule."

RADIO BROADCAST Photograph

THE SALES STAFF OF WEAF

Holding one of their weekly conferences. A large sales staff has been built up by this station, whose activities are similar to those of advertising salesmen. They really sell "time on the air." Payment for this time is helping to solve the often-asked question, "Who is to pay for broadcasting?"

And we learned, during that visit which had been interrupted by the phone call, that program directors are particular folk. It seems that in the case of stations that do not charge for their time, but enjoy the highest reputation, that they are even more fussy as to what they'll accept. In this particular case, the program director has a card index of musical talent available at any time. The same artists are used by different organizations, for that matter, although to the radio audience they are the Dixie Boys for this hour, the Arctic Babies for the next, the Coal Miners' Quartette for another hour, and the Spanish Serenaders for still another hour. These appelations are purely fanciful, of course, but serve to convey the idea. To cite an actual example, a well-known group of versatile musicians was serving a musical concern in an hour's broadcasting feature once a week. Then the musical concern decided the bill was too high, and forthwith departed for another station where the musical standards were of a far lower order, substituting a much cheaper musical talent. Meanwhile, the well-known group of musicians became the such-and-such railroad boys so far as the radio audience was concerned, bringing just as much fame on the new sponsor as for the old. Just a little inside stuff, that!

THE RADIO CORPORATION "CHAIN"

Programs which originate from the WJZ studio are frequently distributed to other stations indicated on the map. Repeater, or stepping up, stations are indicated where the program, forwarded by wire, is increased in volume by amplifiers. In addition to WGY and WRC, WCAD, WBZ, KDKA, and KYW are sometimes included in this group

Smaller broadcasting stations do not seem to be so particular as regards their broadcasting features—but then, they have less at stake. There are some small broadcasters now handling publicity talks which border closely on direct advertising, so much so, in fact, that one knows not whether to call it advertising or publicity. One Western station, for instance, broadcasts a shopping service in the morning and evening, mentioning definite stores, articles, qualities—well, everything but the price. And that is typical of the extent to which some broadcasters have gone in the way of collecting pay for their efforts. Unfortunately, it is a fact that only the largest concerns can see the value of genteel publicity, while the smaller firms will insist on inserting everything, even down to the names of the firm members, where they were born, the size of the plant, the amount of business done and other details of interest to no one else but themselves.

If there is any danger threatening the good will publicity activities of broadcasters, it is in the efforts of some of the lesser broadcasters, who, soliciting the smaller advertisers, are only too willing to promise everything in the way of microphone freedom. However, the radio public, no doubt, can well differentiate between good stations and poor stations, so that in the long run those who abuse good will publicity may only be signing their own death warrant, thereby conferring a benefit on the radio broadcasting field as a whole.

Successful good will publicity via radio is an art, and should accordingly be left to artists. Broadcasters tell us that their experience has taught them that programs prepared by advertising counsellors or even stage directors, and then submitted to the studio staff for censoring and suggestions, are generally successful and fruitful of results for their sponsors. On the other hand, hit-or-miss, hurried-up, crudely prepared stunts are usually wasted effort before the microphone.

Hoggishness is fatal in good will publicity over the radio. Typical of this point is the case of a contracting firm which had arranged to sponsor the initial appearance of a well-known operatic star before the microphone. Instead of the usual sponsoring introduction, the president of the contracting firm spoke for almost half an hour, telling the invisible audience of the size of his firm, how many jobs they handled, the number of men on their pay roll, how much lumber they employed in the course of a year, how many nails, and so on, almost without end, finally stepping aside most graciously so that the prima donna might do her bit. Needless to say, most of the audience, long since disgusted, had gone on to other programs. The sum total was, in the vernacular, "a flop!"

In radio good will publicity, as in other forms of advertising, the well-known saying "Keeping everlastingly at it brings success," holds true. Thus the most successful radio publicists are those who come back week after week, at the same time and day, with a distinctive program. The radio audience is thus trained to look forward to a given program time after time, and a close bond of friendship is established between the public and the sponsors of that program.

As for the tangible results of broadcast publicity, they are not altogether so vague as to be questionable. In fact, the regular radio publicists have had excellent results, not only in the widespread response to their efforts but also in the increased sale of their products or services. Some radio publicists report that their salesmen have received a far more cordial reception when calling on the trade or the public, as the result of the personification of their products over the radio. Well, be that as it may, it must pay; otherwise, we should not be hearing the same sponsors with their excellent programs week after week.

When something is given away, even if it is only a booklet, let alone samples, the broadcasters are virtually flooded with requests, attesting to the widespread influence of radio.

The two greatest factors in the furtherance of radio good will publicity are the chain system of broadcasting and the high-power broadcasting stations. On the one hand, the radio publicist is offered a number of different groups of radio listeners, reached through an equal number of broadcasting stations tied into one studio by means of telephone lines, while on the other, the radio publicist is offered one vast audience by means of high-power broadcasting. The Broadcasting Company of America chain, for instance, represents the leading exponent of the chain system of broadcasting. Upward of fifteen stations are included in this chain if desired, reaching all the way from New York to Boston to Minneapolis and to St. Louis, with many points between.

BROADCASTING COMPANY OF AMERICA

CHARGES FOR NETWORK STATIONS FOR HOURS AFTER 6 P. M.

The individual charges apply only when all the stations available in the network are taken

	CHARGE PER HOUR	CHARGE HALF HOUR	CHARGE QUARTER HOUR	CHARGE FOR 10 MIN.
WEAF, New York	$480.00	$300.00	$187.50	$240.00
WEEI, Boston	350.00	218.75	136.72	175.00
WCSH, Portland	170.00	106.25	66.41	85.00
WTAG, Worcester	170.00	106.25	66.41	85.00
WJAR, Providence	170.00	106.25	66.41	85.00
WGR, Buffalo	230.00	143.75	89.84	115.00
WFI or WOO, Philadelphia	210.00	131.25	82.03	105.00
WCAP, Washington	200.00	125.00	78.13	100.00
WCAE, Pittsburgh	210.00	131.25	82.03	105.00
WTAM, Cleveland	180.00	112.50	70.31	90.00
WWJ, Detroit	230.00	143.75	89.84	115.00
WSAI, Cincinnati	240.00	150.00	93.75	120.00
WLIB or WGN, Chicago	350.00	218.75	136.72	175.00
WOC, Davenport	170.00	106.25	66.41	85.00
WCCO, Minneapolis	250.00	156.25	97.66	125.00
KSD, St. Louis	250.00	156.25	97.66	125.00
WDAF, Kansas City	220.00	137.50	85.94	110.00
	$4,080.00	$2,550.00	$1,593.77	$2,040.00

NOTE: The daytime charge—before 6 P. M.—for groups of stations is one-half of the evening charge for a like period of time. The ten-minute periods are for talks only.

DISCOUNTS FOR DURATION OF CONTRACT BASED ON WEEKLY USAGE

6 months 5%
9 months 10%
12 months 15%

THE BONNIE LADDIES

Who broadcast over the WJZ group of stations. WJZ, unlike the WEAF group does not now accept pay for the indirect advertising programs they broadcast. In essence, the programs from the Radio Corporation group are quite similar to those presented over the A. T. & T. chain, except that no charge is made by these stations for their time

The Radio Corporation of America, on the other hand, operates the powerful WJZ station at Bound Brook, New Jersey, some forty miles west of New York City, by direct wire from the studio in the metropolis. High-power WJZ delivers reliable signals as far as the Mississippi River, thus covering a goodly part of the same area covered by a number of moderate-power stations of the chain system. Furthermore, WJZ is connected by wire with the high-power station at Schenectady, and several other stations throughout the country, thus ensuring nation-wide distribution of programs when so desired.

The reason why chain systems and high power stations have a marked influence on radio publicity is simply due to the millions upon millions of listeners reached through such a medium. Imagine an audience of ten millions! Fantastic, to be sure, yet a nightly occurrence in chain work and high-power work. Little wonder, then, that the radio publicist can afford the highest kind of talent, since pro rata, on the basis of broadcasting stations participating or per listener, the cost is even less than is the case with the individual, low-power broadcaster. And here is the explanation of the appearance of the world's leading artists before the microphone: never before have they performed for such audiences—and incidentally, never before has the sponsor got his name before such a large and appreciative audience.

HOW MUCH DOES IT COST?

SO FAR, so good, But how about the dollars and cents involved? It is a matter of interest to note what the sponsors pay for broadcasting our musical programs.

The rates charged vary largely, depending on the power of the station, the importance of the area, the time of day, the day of the week, whether it is a single feature or a regular series, whether it is good music or simply talk, and so on. Let us not forget to mention, once more, that many leading stations do not charge for the allotted time, but insist on the best musical programs sponsored by others. At present we are dealing with the toll charges for the allotted time, with whatever charges there may be for the musicians.

New York rates lead the rest. It costs $600.00 per hour to broadcast a sponsored program from one of the leading stations in that city, or $375.00 for half an hour, during the late afternoon and evening, which constitute the best part of the day so far as the largest and most attentive audience is concerned. The morning charges are $300.00 for an hour, $117.19 for half an hour. A ten-minute talk costs $150.00.

Chicago follows close on the heels of New York, with $350.00 for an hour and $218.75 for half an hour, with a wire connection from the New York studio. Most of the other large cities command $200.00 or $250.00 for an hour, and $125.00 or so for half an hour. The smaller cities drop down to $150.00 for an hour, and $93.75 for half an hour. All these rates are based on chain broadcasting, operating from the New York studio. The rates of the individual stations, broadcasting from their own studios, are considerably less. Take, for instance, a Buffalo station, whose chain rate is $200.00 for an hour and $125.00 for half an hour. The individual rate becomes $120 per hour and $60 per half hour, thus indicating the additional expenses involved in the chain operation. On the other hand, some stations charge the same rate whether engaged in chain work or individually. All these rates are, of course, exclusive of talent.

Getting down to some of the smaller stations of modest power, it is interesting to note that the prices are as low as $12.50 per hour. In fact, the rate cards—yes, they have rate cards, just like publications!—disclose an interesting analysis of the relative importance of the radio audience from early morning till late night, with corresponding charges. Thus, in the case of a Western broadcaster, his rates are: from 9–12 in the morning, $12.50 per hour; 12–3 P.M., $16.00; 3–6, $18.00; 6–8, $30.00; 8–11 (the cream of the program) $36.00; 11–12 M. $28.00.

Most broadcasters undertake to furnish the musical talent at what is purported to be cost. One broadcaster, for instance, on his very explicit rate card, charges $250.00 per hour from 6–8 P.M.; $400.00 per hour from 8–11; and $200.00 from 11 to 1 A.M., including the music. The choice of the following is offered:

1.—Classical or semi-classical musical programs by string quintette. 2.—Popular or semi-classical program by 4-piece concert orchestra and 2 singers. 3.—Musical program by male quartette and pianist. 4.—Musical program by quartette and solo numbers by mixed quartette and pianist. 5.—Dance program by 6-piece jazz orchestra. Remote programs cost $35.00 more for the first hour.

As a general thing, the day rate runs about 40 per cent. less than that of the evening.

All in all, the business end of radio publicity seems very well organized, following closely that of the periodicals in soliciting advertising. We have seen elaborate charts prepared by broadcasters, indicating just what territories are covered by strong, reliable signals, secondary territories covered by fair signals most of the time, and tertiary territories covered under the best possible conditions.

Paid broadcasting is here to stay, if we read all signs correctly. It is the logical way to pay for broadcasting under our present system. For the most part the public seems well satisfied to accept sponsored programs and to reciprocate by extending its good will to those who make possible the wonderful programs of to-day.

BROADCASTING COMPANY OF AMERICA

CHARGES FOR STATION WEAF FOR HOURS AFTER 6 P. M.

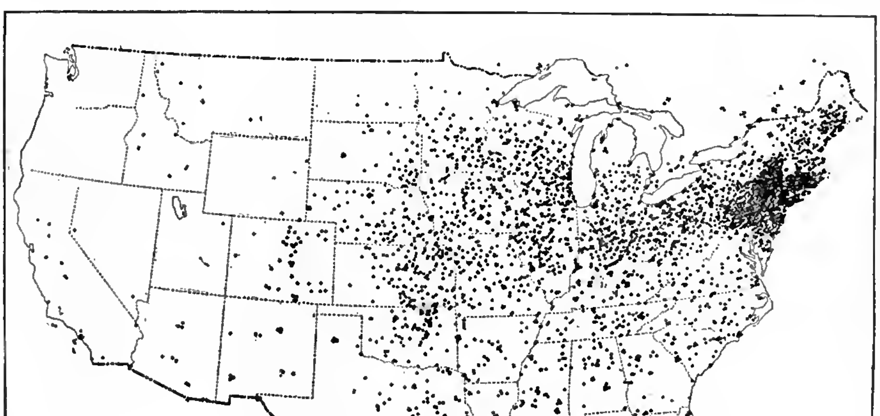
CHARGE PER HOUR	CHARGE HALF HOUR	CHARGE QUARTER HOUR	CHARGE FOR 10 MIN.
$600.00	$375.00	$234.38	$300.00

NOTE: The daytime charge—before 6 P. M.—for Station WEAF is one half of the evening charge for a like period of time. The ten-minute periods are for talks only.

DISCOUNTS FOR WEEKLY USAGE

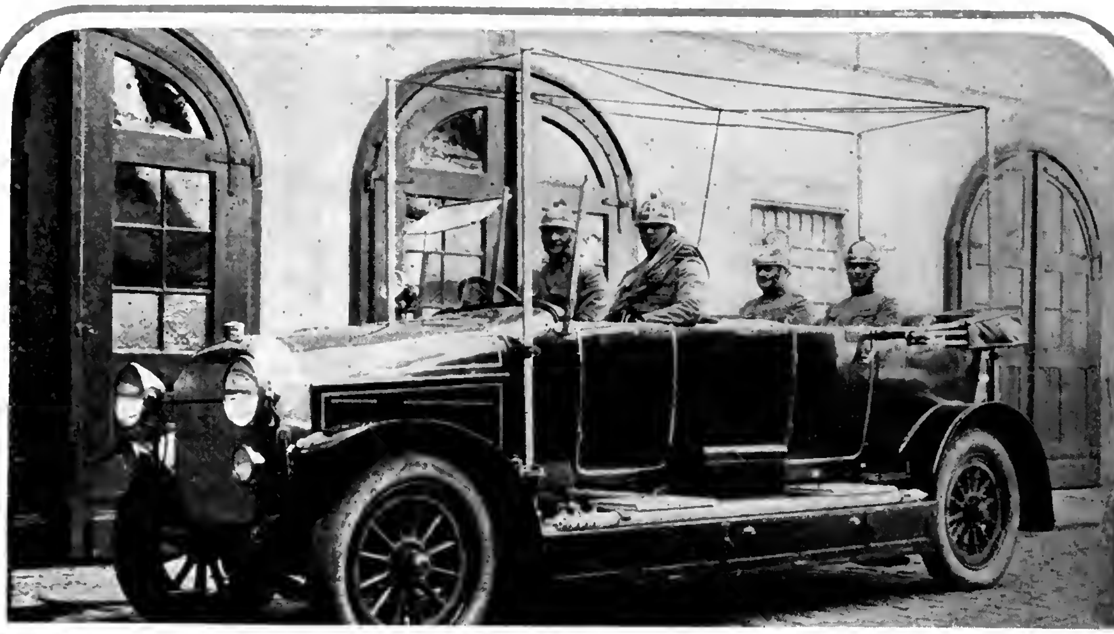
Less than 13 consecutive weeks	Net
13 to 25 " "	7½
26 to 38 " "	10
39 to 51 " "	12½
52 " "	15

Charges subject to change without notice.



HOW WJZ REACHES OUT

Special tests were conducted last February to determine how the signals of this station were received. The dots on the map indicate the points from which letters were received from those hearing WJZ. Engineers designed this station so that under favorable conditions, signals from it could be heard as far west as the Mississippi River



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Fourteen Years Without a Change in Radio Legislation

WHEN the eyes of legislators first turned to radio, some fourteen years ago, they placed its control in the hands of the Department of Commerce. More recently under the conscientious care of Secretary Hoover, it has been safely guided through a period of flaming youth. But radio is now about ready for a nervous breakdown, having been jilted by Congress just as the age of spinsterhood approaches.

Alarmists predict chaotic days for radio. In Chicago courts, a decision has been rendered, confirming the obvious fact that there is no authority vested in the Department of Commerce or any other branch of the Government to prescribe a particular wavelength in the broadcasting channel to each station. Another decision, in the District of Columbia, makes it compulsory upon the Department of Commerce to issue broadcasting licenses to all who apply. An unconfirmed report from Chicago states that, acting in accord with these decisions, the Chicago Federation of Labor plans to appropriate WEAF's wavelength with a high power transmitter in that city. With radio neglected by Congress and the Department of Commerce defeated in the courts, Secretary Hoover would be justified in surrendering the control of radio to the tender mercies of anarchy.

The illustration forming the heading above shows a car used by the Vienna fire department. A receiving set is carried aboard and enables the officers to keep in constant touch with the central bureau

While it is possible that some of the 650 applicants for broadcast station licenses, emboldened by these court decisions, may begin operating on wavelengths already in use, we feel certain that common sense will rule the situation. Even without legal control, the present set-up of wavelength allocation and regulation is sufficiently sound to survive a short period of self-government.

But the failure of the legislative branch of our government to pass radio legislation, however imperfect, is not to be condoned. If a period of confusion arises, it will rightly be laid at the doors of our legislators who willfully mingled this nonpartisan problem with political wrangles.

Briefly, any satisfactory radio legislation must clarify the following basic points:

1. Who shall administer the radio law?
2. Under what conditions shall licenses be extended to applicants for broadcasting stations so that the limited number of channels available shall be most equitably distributed?
3. What regulations, if any, shall control the political use of the broadcasting medium?
4. What shall the liability of the broadcasting station be with respect to slanderous and libelous statements?
5. What power limitations if any, shall be imposed?
6. If owners of copyrights permit one station to use their material shall they be compelled to extend the same right to other stations upon the same terms?
7. Under what conditions should preventable electrical interference be considered an invasion of public rights?

Our radio law will not be complete until satisfactory legislation covers all these points. Each one is a highly debatable question.

Our views on the very fundamental questions listed above, follow:

1. The Department of Commerce, under its present head, has demonstrated its ability to cope with the problem of the regulation of broadcasting. The dictatorial powers lately assumed by the Department are the outcome of the failure of Congress to enact a radio law and do not, in themselves, constitute an argument against future regulation by the Department. We do not favor a commission similar to the Interstate Commerce Commission for the regulation of radio because radio is *not* a public utility, being non-exclusive and nonessential; and second, because a commission consisting of political appointees is both expensive and inefficient. Adequate safeguards against usurpation of power can

be incorporated in the law so that radio legislation may be administered in the same manner that marine regulation, irrigation, currency, and numerous other activities of our government are conducted.

2. We believe in the recognition of the principle that a station established with a wavelength which gives satisfactory service to the public has a priority over that wavelength regardless of any number of followers who may later covet it. We do not believe that any regional allocation of wavelengths so far proposed, either upon the basis of the nine radio districts or upon the basis of one wavelength to each state of the union, is at all satisfactory or reasonable. The Department of Commerce, supported by an advisory commission (not an executive one) or through deliberations, such as the annual radio conferences, can determine a regional distribution of exclusive wavelengths which will best serve the public.

3. The American press has prospered without undue political control, and any move to make radio the football of politics is inimical to the public interest. The object of broadcast stations is to secure listeners, just as newspapers seek to secure readers, and this controlling factor in itself is ample to obtain a hearing for all parties concerned. Let us have no regulation which compels a broadcasting station to permit all sides of any question to be presented, lest the broadcasters elect to eliminate *all* political and educational features.

4. Although the broadcasting station does not have the same control that the newspaper has over what goes out through its medium, it should be held liable for what speakers say. One of the points in determining that liability is whether the speaker followed the copy submitted and approved by the station or whether he willfully changed the nature of his remarks from the submitted material.

5. A maximum field strength, based upon some such unit as microvolts per meter, which any station, regardless of location or power, may set up in cities above a certain size, could well be established. This would permit the erection of adequately powered stations in sparsely populated districts and would, at the same time, prevent blanketing in congested areas. Any regulation adopted, however, should be subject to modification without special legislation because of the rapid changes in the radio art.

6. The control of a copyright should be fully protected. But, when an author or composer permits broadcasting of any particular composition, we feel that he has elected to place it at the disposal of the public through the broadcasting medium. Therefore, a maximum basis of charges should be determined upon which assures an adequate return to the author or composer, but which shall not be prohibitive to broadcasting stations. In phonograph recording, a composer who permits one phonograph company to record a number thereby automatically permits all others to do so at the same rate. The maximum charge per number is limited by law. Some such arrangement is possible for broadcasting.

7. Preventable interference with radio reception is as much a public nuisance as the erection of a refuse incinerator plant in a residential district. Distinction, however, should be made between existing electric systems and new installations, just as one finds in building regulations in the large cities. Much preventable interference is caused by the equipment of public utilities whose rates and income are limited by public service commissions. Expensive changes in equipment, such as substituting underground third rails for overhead traction wires, cannot be accomplished without providing necessary funds. A newly installed smoke precipitator, interfering with large numbers of listeners, is a wanton outrage upon radio listeners which should not be permitted by law.

The legislative situation, at the close of the present session of Congress now is that the House has passed the White Bill, placing the control of radio in the Department of Commerce. The Senate, aftei oratorical absurdities of almost every possible kind, passed the Dill Bill, providing for an independent regulatory commission. The measures then went to conference on the day of adjournment. No agreement was reached. So legislation must await the pleasure of the next and 70th session of the Congress.

STATION JOCK AT NAGOYA, JAPAN

The top view shows a corner of the European type studio showing a block of ice which was used for cooling purposes when the station was opened and before the permanent cooling arrangements were completed. The sound of water, dripping from the melting ice to the pan below was distinctly heard during the early transmissions. The equipment is British Marconi and has a power at the plates of the tubes of 6 kw. The wavelength is 360 meters (832.8 kc.) The lower cut shows a Japanese Orchestra there in full swing

The Good Side of a Poor Year for Receiving

THERE has been much speculation among long distance enthusiasts as to the causes for less satisfactory receiving conditions during the past season. Many unproved explanations have been offered, but it must be admitted that we know little or nothing about what occurs between the transmitting and receiving antennas.

OTIS STANTZ, CHIEF RADIOMAN, U.S.N.
Who, with two aviation pilots, was commended by Admiral W. R. Shoemaker, chief of the Bureau of Navigation for performance of duty and conduct during the hazardous flight over the Pacific in *PN-9 No. 1*. Others cited were Radiomen Wisendanger and Aubin

In one way radio is fortunate at this stage of its development to have had a season which was unusually poor in DX possibilities. It coincides with a period of greatest development in improved faithfulness of reproduction. Therefore, the experimentally inclined turned their attention to the more perfect and faithful reception of local stations rather than concentrating upon the useless but intriguing hunt for greater distance. Appreciation of tonal quality has, in direct consequence of this shifting of emphasis, taken many steps forward.

One of the theories advanced for lessened DX reception, is that so many high power stations, working through the so-called ether, cause a blanketing effect. This may be the explanation in congested districts, but a very large percentage of the country's area remains relatively unaffected by this condition, having no high power broadcasting station within several hundred miles. In these ideal receiving areas, we find the same general complaint of mediocre long distance reception.

On the other hand, so far, the summer has been excellent for radio reception. In fact, results comparable to those secured in winter are widely reported. We have just unpacked a small, portable receiver less than fifty miles west of New York and have heard three stations over four degrees of the dial, New York, Baltimore, and Richmond, each with loud speaker volume and enjoyable clarity. More than thirty stations are heard, without objectionable atmospheric noises, six days out of seven. Programs are maintained at most of these stations up to full mid-winter standards and it may be truly said that broadcasting has become a year round entertainment.

The mid-summer unpopularity of radio reception is the heritage of the days of headphone reception. Receivers, uncomfortably clamped to the ears in hot weather, accentuating every thud of static, certainly did not encourage summer radio entertainment. But, with greatly increased power of stations, loud speaker reception, and the desirable habit of listening to nearer stations firmly established, there is, under usual conditions, but little diminution of the pleasure which may be derived from a good radio receiver.

Operating Two Stations on One Wavelength

FROM Boston comes news of an interesting experiment which yields promise of important developments. WBZ, the Westinghouse station at Springfield, although but eighty miles west of Boston, through inexplicable obstinacy of the ether, is not heard well in the latter city. Accordingly, WBZA was established in Boston and connected by wire line with Springfield. Recently both stations began operating experimentally on exactly the same wavelength and it is reported that a successful means has been found to avoid heterodyning, presumably through the use of crystal control. Both stations can now operate upon the same wavelength, supplementing each other successfully.

It has been suggested from time to time that stations broadcasting the same programs simultaneously should operate on the same frequency, thus conserving ether lanes. Synchronizing fifteen or twenty stations under any circumstances would be no small matter and, until the successful experiment in Boston, it was considered impossible of accomplishment.

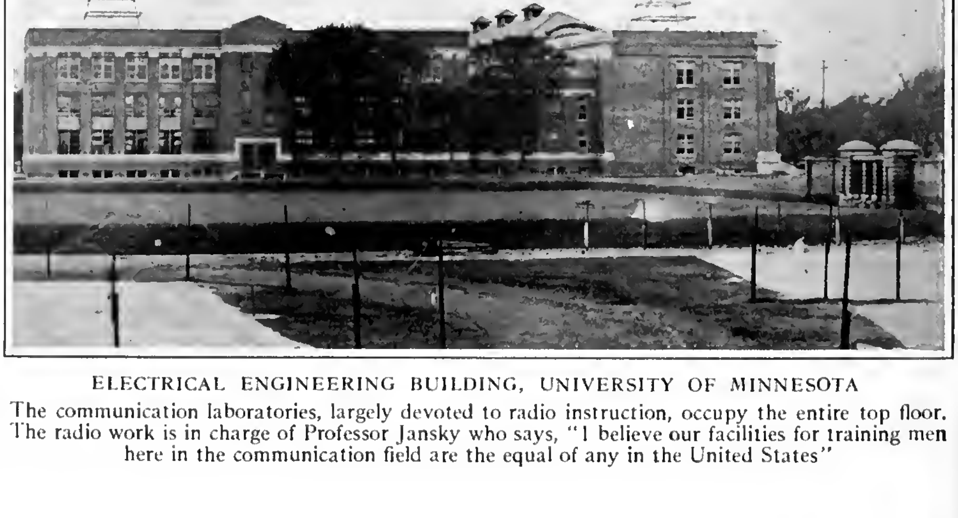
A listener located midway between two stations, operating simultaneously on the same frequency, would probably receive energy from both of them. Those who have a fancy for DX reception would no longer be annoyed by hearing the same program come through from ten or twelve stations.

Both of these contributions are of minor importance, but the release of many wavelengths, if it could be accomplished by this means, would be a great advantage. It is quite conceivable that eventually most of the stations on existing wire networks will take practically their entire programs from the network, thus making an individual wavelength for each station unnecessary.

Rain Is Independent of Radio

SINCE radio waves are invisible, they are freely blamed for any inexplicable phenomena. Recently Henri Painlevé secured international publicity by a statement offering the intensified activity of radio stations as a cause for the cool and rainy weather in Europe. With so eminent a personage the source of the statement, it is natural to suppose that is has considerable scientific foundation. However, M. Painlevé's contention is quite unsupported by conclusive evidence. Certainly, if radio affects the weather in Europe, it would have ten times the effect in the United States where there are many more stations and much higher power is used.

We have delved into the weather records since 1826 and find that, in the New York area, for example in the last hundred years, there have been seven Aprils with six or more inches of precipitation. Each of these occurred before 1922 when broadcasting stations became active. Of the five Mays with more than six inches pre-



ELECTRICAL ENGINEERING BUILDING, UNIVERSITY OF MINNESOTA
The communication laboratories, largely devoted to radio instruction, occupy the entire top floor. The radio work is in charge of Professor Jansky who says, "I believe our facilities for training men here in the communication field are the equal of any in the United States"

cipitation, none were since 1922; of the twelve Junes, only one was since 1922. The average rainfall by months from 1826 to 1922, for April, May, and June respectively, is 3.32, 3.46, and 3.48, while for the same months, 1922 to 1926, inclusive, it is 2.49, 3.06 and 3.61. The latter figure does not include June, 1926, which, at this writing, is running below normal.

The average annual precipitation, 1871 to 1925, is 42.86 inches. Since 1920 there was only one year above this average and that was 1922, while the average of 1921 to 1925, inclusive, is 37.54 inches.

As to temperature, while June, 1925, broke all of metereologist James H. Scarr's records, to whom we are indebted for these figures, still the average of the last five years is but .8° above that of the last 54 years.

Let any and all accusers of radio stand forth!

Explaining Vagaries of Radio Transmission

WHEN Anaxagoras, more than four centuries before Christ, propounded the theory of infinitely divisible and continuous matter, upon which the conception of the atom is based, there were few loop holes to be found in it. As scientific knowledge increased through research, things were discovered which could not be reconciled with this theory. So the indivisible electron was added to this defective conception of the construction of matter. These electrons are supposed to vibrate in a medium which has been termed the ether, in all-pervading nothingness through which all unexplained wave motions travel.

The old illustration to explain the action of a radio transmitter by likening it to a stone thrown in the pond is familiar to every reader of radio textbooks. But, as Dr. J. H. Dellinger of the Bureau of Bureau of Standards points out, modern scientific discoveries have divulged many imperfections in this theoretically uniform medium, the ether.

"The way our ignorance is camouflaged," says Doctor Dellinger, "may be handsomely illustrated by the following remarkable description of the accepted theory:

The magnetoionic hypothesis, whereby the electronic phase velocity is so modified that there is a rotation of the plane of polarization for propagation along the earth's magnetic field and double refraction for transmission at right angles thereto.

As we delve further into the field of high frequency transmission, old theories tremble and new ones are propounded upon insignificant evidence at a very rapid rate. But it must be borne in mind that theories do not prove facts but that facts establish theories. Too often are accepted theories modified to fit some isolated fact.

To the public, these all too frequent announcements of revolutionary discoveries are accepted as proved facts. How much wiser it would be, now that statements from laboratories and universities receive such wide attention, to await scientific proof before broadcasting new theories to the world.

The Ocean Newspaper—By Radio

WHEN the first newspaper was published on shipboard with the aid of items secured by radio, it caused a considerable stir. For a long time, the broadcasting of news items by radio telegraph was incidental to the business of various radio operating companies.

But the collection and editing of news items for ships at sea has gradually been handed over to specialists. How extensive this tendency is may be gleaned from the fact that the Chicago *Tribune's Ocean Times*, according to its editor, Perley Boone, is now serving no less than seventeen steamship companies and several private yachts. Mr. Boone selects four or five leading news stories, makes up an imaginary page one and radios the stories in the order of their importance, accompanied by display headlines.

The radio operators on ships receive the news according to a standard formula and turn it over to the printers aboard ship. The type is then set—some of the ships have linotype machines and others set by hand—and the wireless news is then printed on blank pages left in predated newspapers of eight to twenty pages. Through this system, the printer aboard ship is given his news dispatch already edited and "made up," and, when the passenger gets his paper at breakfast or lunch, he has a complete, although miniature, metropolitan newspaper, edited on land, radioed to sea, and with a radio news section printed at sea.

Among the lines being furnished by the Chicago *Tribune's* service are the United States Lines, the White Star, Red Star, Royal Mail, and Atlantic Transport. The newspaper is distributed by the Radio Corporation of America through WRQ at Marion, Massachusetts.

Broadcasting Is Not a Public Utility

A DEBATE on the subject of freedom of the ether was recently broadcast through WRNY with Dr. Norman Thomas of the League for Industrial Democracy urging that stations be compelled to permit speakers of both sides of any question and Hugo Gernsback, Editor of *Radio News*, defending freedom of operation on the part of a broadcasting station. Apparently, Mr. Gernsback had somewhat the better of the argument.

Of the 550 broadcasting stations now operating, less than 5 per cent. are owned by any one interest. Although patents make the construction of a practical transmitter impossible without infringement, owners of patents are not taking advantage of their rightful monopolies, but sell broadcast transmitters to all who can afford to purchase and use them.

C. M. JANSKY, JR.
Minneapolis

Assistant Professor of Radio Engineering, University of Minnesota; in a paper before the Institute of Radio Engineers:

"The radio industry has enjoyed a remarkable growth during the last decade. It is not to be expected that such growth would take place without its problems. During the period when any radio manufacturer could sell equipment faster than he could make it regardless of quality it is small wonder that many have seen no necessity for services of well-trained engineers. However, conditions are changing rapidly. The public is already beginning to discriminate in favor of those manufacturers whose apparatus has been designed and constructed under the supervision of competent engineers. This discrimination on the part of the public will do much to stimulate development and improvement. It will also bring about greater rewards to those who have sacrificed time and effort necessary to secure an adequate training in what is the youngest as well as one of the most technical of the electrical sciences."

To regard a broadcasting station as a public utility is to stretch the meaning of that term far beyond its original meaning. A public utility performs a service which is essential and which can be performed successfully only by a monopoly. It is accordingly granted a monopoly by governments and regulated so that it does not take advantage of that monopoly.

Broadcasting is, in the first place, nonessential. Even from our biased viewpoint, we must admit that some civilization existed before 1920. Broadcasting is not a monopoly, because hundreds of stations are in operation, giving ample opportunity for all sides of any reasonable question to be presented.

Some assert that if a speaker of one political complexion is permitted to broadcast at a station, one from the opposing side should also be given access to the ether through the same station. On this principle, no station could broadcast a talk on good government without inviting an anarchist. One could not have a talk on uniform matrimonial laws without hearing an advocate of free love.

As Mr. Gernsback ably pointed out, a radio station may be compared to a newspaper. Its popularity depends upon appealing to the public tastes and interests and, consequently, any one who has something of sufficient importance to secure the attention of any considerable part of the radio listening public can easily obtain a hearing. We must heartily disapprove of any tampering with the development of broadcasting by the adoption of censorship or regulatory legislation.

The Month In Radio

THE Northwest Radio Association has set a good example to all similar organizations by its active promotion of radio retail business in its territory. It will spend, according to an announcement, $150,000 in 1926 to promote the sales of radio sets.

Another example of a similar nature is the action of the retailers of Buffao, New York, who by an assessment, are supporting with paid talent the programs of several near-by stations. They believe that improvement of programs means the betterment of their business and they have backed up this belief with real hard-earned dollars.

ONLY one of the 642 applicants for a broadcast license has withdrawn. A Department of Commerce estimate reports 817 active broadcasting stations in the world; 534 in the United States and 283 in 57 other countries. There are 98 projected stations abroad and 642 in the United States. If all went into operation, the total would amount to 1557. Canada is second to the United States with 37 stations, 2 projected, 4 suspended and 11 others using other stations. Australia, the United Kingdom, and Spain each has 20 broadcasting stations; Mexico and China 19 each, France and Cuba 18, Sweden 17, Brazil, 13, Argentina and Finland, 10; Russia only 3 with 18 projected.

THE government of Bermuda has established a comprehensive set of regulations for radio transmission and reception, providing for two broadcasting bands, one from 1 to 125 meters, the other from 200 to 295 meters. Amateurs will be permitted on the lower band and also may use 20 watts between 135 and 199 meters. In the upper 50 meters of this band, a silent period from 7 P. M. to midnight is provided for. Annual fees of 2, 5, and 20 shillings are required for crystal receivers, tube receivers, and broadcast transmitters respectively.

OF THE $22,281,000 valued exports of radio materials from the United States in the four years 1922 to 1925, Canada took $7,709,000, or about 35 per cent.; South America 25 per cent.; Australia 8 per cent.; and South Africa about 1 per cent. each.

The Statistical Division of the Department of Commerce makes as its unofficial estimate the figure of $100,000,000 as the value of radio material made in 1925. Ninety per cent. of this went to American purchasers and 10 per cent. overseas. Exports for April, 1926, were only $405,525, as compared with $820,038 in March and $835,148 April a year ago. Evidently, the radio industry is not taking increasing advantage of the foreign market to stabilize its production in dull periods.

THE official gazette of the United States Patent Office publishes notice that the Westinghouse Electric & Mfg. Co. has filed suit against the Bruno Radio Company for violation of the Armstrong radio patent, No. 1,113,149; that the General Electric Company has filed suit against the Meyers Radio Tube Corporation, citing one of Langmuir's electron discharge apparatus applications; that the DeForest Radio Company has been sued by the General Electric Company under various Langmuir patents.

THE International Radio Advisory Committee announces a recommendation to adopt a frequency of 290 kilocycles (1034 meters) for the exclusive use of aviation beacons and the reservation of the band between 285 and 305 kilocycles (1052 and 983 meters) for all forms of beacon service. The only landing field in the United States at present equipped to send radio beacon signals is at Dayton, Ohio.

THE Bell Telephone Laboratories have purchased a large tract of land in Whippany, New Jersey for the erection of a high power radio station, to be used for "experimental purposes." Detailed plans for the station have not been announced, although there are those who suspect that WEAF's radiations will eventually be impressed upon the ether from that point. This statement is particularly interesting in view of the recently announced sale of WEAF.

THE *Lightning Jerker* is the name of a new publication which made its bow in June, published for the benefit of the professional American radio operator. We are pleased to see this newsy little contemporary, filling the need in a field which has been badly neglected. Commercial operators will find it worth while entering their subscription to the *Lightning Jerker* by writing 3850 North Avers Avenue, Chicago, Illinois. To the broadcast listener, discussion to the effect that Powers is "about the cream of bug senders" and that Francis Brown, on the other hand, is "the bees' knees with the cootie key" is hardly of interest, but it is as lively as a topic of discussion among commercial operators as the sensitiveness of Hammarlund-Roberts versus super-heterodyne among the entertainment-seeking fraternity.

AN INTER-STATE radio conference, held at Sidney, Australia, brought to public attention the fact that, of the $4,500,000 spent for radio sets and material in the commonwealth, fully $2,500,000, or more than 50 per cent., went to the government in the form of customs duties. Nevertheless, a report from another source indicates that the number of receivers in Victoria increased from 33,000 to 45,000 in three months; that is, one set for every seven families.

Interesting Things Said Interestingly

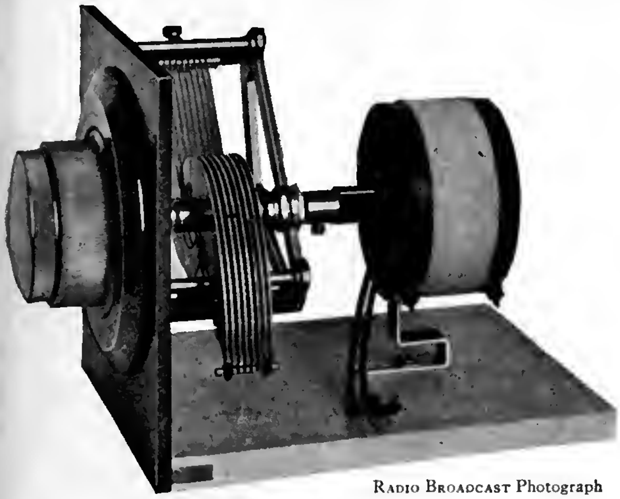
GRAHAM MCNAMEE (New York; announcer at WEAF, writing in the *Saturday Evening Post*): ". . . as we undoubtedly would make but indifferent reporters in print, so the newspaper man does not always make the best broadcaster. Once I sat in with an editor—an expert, too, with a powerful style and a keen wit. Somehow, perhaps through self-consciousness, but I don't think it was altogether that, he found it difficult to pick out the right things to tell; those that might score on the printed page were not so interesting on the air. An effect gained in one medium, you see, will not always get over in another. A musician may give the suggestion of color in the tone of a violin, but not with paint on canvas; and a fine actor cannot always write so well as he talks. So it is with our respective callings."

NORMAN THOMAS
New York
Executive Director of the League for Industrial Democracy; over WRNY

"There must be no censorship of radio speeches on the basis of the prejudice or fears of station managers. It can be illustrated by the experience of a friend of mine who is a professor at a famous college. He has lived and worked in the Near East and was invited to broadcast an appeal for relief, from a certain New England station. In accordance with custom, he sent in his speech in advance. The manager objected to it because he said that some people would not like some or the opinions expressed, and, to make a long story short, he finally forced my friend at the last moment to use what was virtually another man's speech. This is, of course, intolerable. It assumes that anything said from a station must be so colorless as to meet with no objection from anybody. No wonder the average radio fan prefers any sort of jazz or jest to speeches so dull. I can see some reason why program directors should be given the privilege of looking over speeches in advance. They might make very helpful suggestions, but no magazine editor—and remember, magazines are not public utilities—would exercise his editorial power in such autocratic fashion as do some station directors."

LEWIS M. CLEMENT (New York; Director of Reception, F. A. D. Andrea): "Obviously, simplification of controls is coming. I believe the ultimate is a two-dial control, but only on the high-grade and, in consequence, expensive sets. Two dials make a set which is easier to design and less likely to give trouble than the single-dial set, and one which, of course, loses less on efficiency. The two-dial set has advantages over the single-dial receiver in that the operator may pick up stations whose signal intensity is weaker than that which it is possible to pick up with the single-dial set."

Higher Efficiencies for Radio Frequency Circuits



Radio Broadcast Photograph

FIG. 1

Shows the degree of coupling at maximum. The stationa·y coil has been pushed over the movable coil. The axis of the larger or secondary coil coincides with the condenser axis so the coupling is the same at all frequencies

Details of the Tuning Problem in Radio Frequency Circuits—The Importance of Optimum Energy Transfer at All Frequencies—The "Equamatic" System for Automatically Varying the Coupling with Frequency—Applications of the System

By ZEH BOUCK

THE tuning of a radio circuit is nothing more than a simple proposition in efficiency. When we say that a receiver is tuned to a certain frequency or station, we mean that its capacitative and inductive values (condensers and coils) are so adjusted that a radio signal of the designated frequency will vibrate through the circuits with the lowest possible loss—in other words, with the highest possible efficiency.

If the set in question is a good one, no signals ten or more kilocycles away from the tuned station will be heard, due to the fact that the efficiency on other frequencies is so low that the energy (pounding-in on the antenna whether it is heard or not) is hopelessly dissipated. When you tune to another station, you merely shift the point of highest efficiency of your receiver.

There are several individual circuits in the average receiver—a grid and plate circuit for each radio frequency tube, and the antenna circuit. Each control—each dial on the set—governs the efficiency of one of these circuits. If each circuit is tuned individually to its point of least loss for the reception of a given signal, the entire system will operate at its highest efficiency on this same frequency. The idea is that of a chain with no weak links. If the efficiency of one circuit is lowered, the loss over the entire system is increased just so much, and the signal strength impaired. That this is so may be easily demonstrated by detuning one of the dials on your own receiver.

THE MORE CONTROLS, THE HIGHER THE EFFICIENCY

A CONSIDERATION of these facts might lead one to think that the more sensible controls one could add to a receiver, the more efficient the set would be if operated correctly. This logical idea is quite true, and accounts for the very high relative efficiency of old and modern commercial equipment. In prewar days, the shipboard receiver was a maze of from seven to twelve controls built up around a crystal detector. The operator spent months in getting acquainted with his apparatus, and his deft fingers coaxed consistent signals from relatively inefficient transmitters two and three thousand miles away.

One of the most vital controls on commercial equipment is that varying the coupling (the coil relations between circuits)—an adjustment that contributes greatly to selectivity and general efficiency. The experienced operator appreciates that his coupling adjustments are second in importance only to those controls more directly affecting wavelength—the so-called tuning dials.

THE DESIRABILITY OF VARYING COUPLING

COUPLING is a primary necessity in radio circuits, and is the means of transferring high frequency energy from one circuit to another to achieve certain desirable or necessary effects. Were it not for coupling of some sort, the signal in the antenna would never reach the detector circuit.

There is an optimum or most effective value in all electrical and mechanical devices. An automobile engine, for instance, operates best at a given spark adjustment for a given r.p.m. At higher or lower speeds, the spark is respectively advanced or retarded.

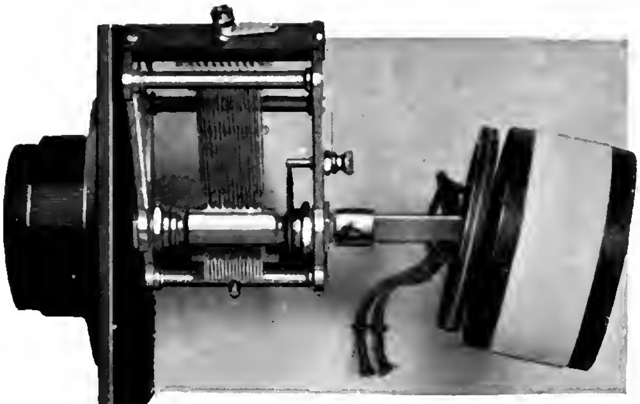
So it is with radio circuits. At a given frequency there is an optimum amount of power or energy to be transferred from one circuit to another, variations from which detract from the practical efficiency of the circuit. ("Practical efficiency" is an expression of the listener's enjoyment, and does not necessarily coincide with electrical efficiency.)

The optimum value of energy transfer from one circuit to another changes more or less with the frequency—sometimes directly with the frequency and sometimes in a reverse order, depending upon the division of a receiving system in which the coupling is employed. (The coupling we are considering in this article is mainly "inductive"—the coupling caused by the interaction of the magnetic fields of two coils placed near to each other.) In other words, as the wavelength is shifted, more or less energy should be transferred from one circuit to another, in order to maintain the highest possible receiving efficiency at all frequencies.

ANY practicable method for maintaining the efficiency and stability of tuned radio frequency circuits by means of varying the magnetic coupling at the same time the frequency of the circuit is varied has never been made available for the home constructor. This article by Mr. Bouck will interest every radio constructor, we are certain, because it introduces the details of a practicable system which can be simply applied to many types of excellent circuits. The author, has been working for months to reduce the details of the system to such simplicity that the army of home constructors could use it effectively. This article is the first of a series. The next will describe the construction of a five-tube, tuned radio-frequency receiver using this interesting method of coupling.

—The Editor.

It happens that the amount of power transferred from one circuit to another varies automatically as the frequency changes, *but seldom in the correct direction, and almost never in the correct degree.* The energy transferred between circuits increases roughly with the square of the frequency, and also with the square of the mutual inductance (or magnetic interaction) of the two circuits. The mutual inductance is a function of the coupling, or the nearness of the two circuits one to the other. As the coils are brought closer together the mutual inductance is in-



Radio Broadcast Photograph

FIG. 2

The large coil has been pushed back so that the coupling between the two coils is now quite loose. Also, there is now a small angle and the coupling will decrease as the condenser setting is decreased

creased. It is therefore possible to compensate the variations in energy transfer due to frequency change (as the set is tuned)—to maintain this transfer always at its optimum value—by the simple expedient of coupling adjustment (which is a determining factor of the mutual inductance).

Having laid down these principles, we can now reconcile them to practice.

WHERE COUPLING IS USED

INDUCTIVE coupling is employed in four instances familiar to the fan. They are as follows:

1. Between the antenna circuit and the input to the first tube. As a general rule, the amount of power transferred should remain fairly constant over the entire tuning range. In other words, the coupling should be loosened as the frequency becomes higher. With unusual antenna conditions this movement may be reversed.

2. Between tickler coil and grid circuit in a regenerative receiver. The correct transfer may increase or decrease slightly on the lower frequencies (longer waves) depending upon the characteristics of the coils. At any rate, to maintain the circuit at the desired point of regeneration over the tuning range, the coupling should be increased as the frequency is lowered. The correct amount and rate of increase, as suggested, will vary with different receivers.

3. In reversed feedback circuits such as the Superdyne. Here again the variation in coupling between tickler and secondary will increase the efficiency of the receiver.

4. In standard tuned r. f. systems. Such receivers employing a fixed relation between primary and secondary circuits are adjusted for the optimum transfer of energy on only the higher frequencies (shorter wavelengths). Since the coupling is fixed, these sets are comparatively inefficient on frequencies less than 1000 kilocycles (waves longer than 300 meters), due to the drop in energy transfer which, it will be remembered, varies with the square of frequency. This undesirable effect is further increased by the fact that the optimum value of energy transfer for such circuits is greater at the lower frequencies than at the higher. The result of the maladjustment is lack of sensitivity on the longer wavelengths. To correct this condition, the coupling should be increased as the frequency is lowered.

Before proceeding further, let us recapitulate two propositions to be maintained clearly in mind. Firstly, all other things remaining constant, the amount of energy transferred from one circuit to another changes with the frequency. Secondly, to compensate this change, the optimum amount of energy transfer may be attained at any frequency by changing the coupling between the circuits.

It is by now apparent that the variation of coupling is essential to the operation of familiar radio circuits at their highest possible efficiency. However, coupling controls have been eliminated from all but regenerative broadcast receivers in order to simplify the apparatus, regardless of the considerable sacrifice in possible efficiency. I write "possible efficiency," because the average fan would never study his receiver, as the ship operator does, and would not, therefore, take more than a slight advantage of his receiver's inherent possibilities. Indeed, with the multiplicity of controls, and their interaction, one upon another, it is doubtful if the ordinary enthusiast would secure as excellent results from an elaborately controlled receiver with coupling controls as he does on the more simple if less efficient tuned r.f. arrangements.

However, it has long been appreciated that if it were possible to develop a method of automatic coupling variation that increases or decreases coupling to the correct degree over the entire tuning range—a method that would contribute all the efficiency of coupling variation without an additional tuning complication—we should greatly enhance the possibilities of the broadcast receiver. And this brings us to——

THE KING EQUAMATIC SYSTEM

THIS arrangement is named after Louis G. King, who developed the idea we shall describe, and which solves the problem suggested in the preceding paragraph with charming simplicity. Fundamentally, the device consists in mounting one, of two coupled coils, on the shaft of the tuning condenser in such a manner that the coupling is varied as the condenser dial is turned, i.e., as the set is tuned. Thus the operation becomes automatic, and no controls are added to the receiver. (The interaction between coupling variations and resonance control, or tuning, is, of course, automatically compensated through a slight curving of the condenser frequency line.)

A glance at the accompanying illustrations will explain the manner in which coupling changes are adjusted and effected. When certain conditions are known, such as one would learn after building several receivers of one certain circuit, it is possible to set the axes of the coils and condenser shaft at a predetermined angle. However, as set forth in our discussion on coupling, there are several variable factors in the case of the average receiver which make it necessary for the device to be capable of adjustment in reference to the following:

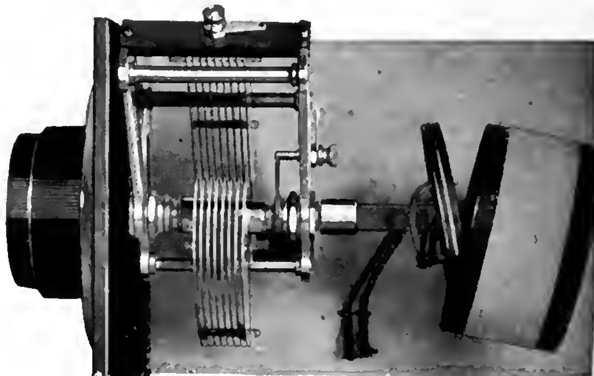
1. The degree of coupling at maximum—the tightest coupling to be obtained at any tuning point, generally the longest tunable wavelength. For instance, in Fig. 1, the stationary coil has been pushed over the movable coil for close coupling. In Fig. 2, the stationary inductor has been moved back for loose coupling. In any of the other illustrations showing maximum coupling (Fig. 3,) this adjustment can be similarly made by moving the larger coil *back and forth*. Once the optimum coupling is determined at maximum (a very simple process), it only remains to adjust—

2. The acceleration of coupling change, which governs the minimum coupling. This is accomplished by varying the angle between the axis of the coils and the axis of the condenser *at maximum coupling*.

Let us assume that we wish to loosen coupling as the frequency is increased (as the wavelength decreases with the adjustment of the condenser) which is the usual condition. In Fig. 1, the axis of the condenser coincides with the axis of the large or secondary coil. Therefore the coupling between the primary and secondary will remain constant, regardless of the dial position.

Fig. 3 shows the high frequency position (condenser out), with the coils turned to a small angle. Fig. 4 is a photograph of the position at long waves for the same angle. Coupling has been gradually increased as the condenser has been turned "in"—for the coupling is, of course, greatest when the coils are parallel one to the other.

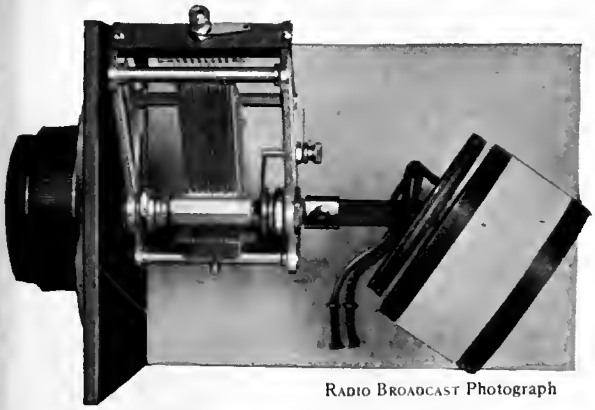
Fig. 5 is a short wave position (loose coupling) with the angle considerably increased. As the condenser is turned down (as the wavelength is decreased, or the frequency increased) the coupling between the two coils is loosened much more rapidly than with the smaller angle, and with the con-



Radio Broadcast Photograph

FIG. 3

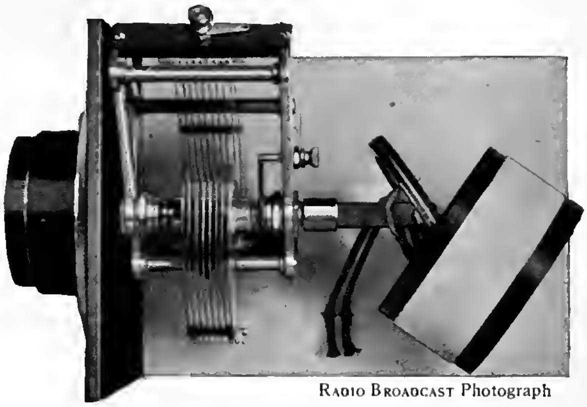
With the coils placed as in Fig. 2, the condenser was turned to zero. Note how the coupling has been automatically decreased. Herein lies the advantage of the Equamatic system. The method of mounting the movable coil on the condenser shaft is clearly shown in this Figure



Radio Broadcast Photograph

FIG. 4

Here, with the condenser plates completely meshed, the degree of coupling is the same as Figure 2, although the angle has been increased. But as the dial is rotated watch what happens at the high frequencies!



Radio Broadcast Photograph

FIG. 5

Coupling at the high frequencies. Note how loose it is in comparison with the coupling at the low frequencies. By adjustment of the angle, any desired degree of acceleration of coupling can be obtained as the condenser is revolved

denser all the way out, it is very loose indeed.

So it is thus possible to secure any maximum coupling desired, as well as any acceleration in coupling. With the correct size and type of condenser, one is able to adjust the transfer of energy to meet any of the possible conditions.

MECHANICAL DETAILS OF THE EQUAMATIC SYSTEM

THE mechanical arrangement is best made clear by the photographs. Fig. 6 shows a simple form of mounting for the moving coil. The condenser should be of the straight frequency-line type, with the shaft extending through the lower end plate. A number of commercially available condensers, designed for ganging, meet these requirements.

Further constructional data are also suggested in Fig. 6. From left to right we have a stationary coil with mounting bracket; a condenser extension shaft; a movable coil arranged for simple mounting; and a more elaborate moving coil device mounted on an extension shaft.

IN ACTUAL CIRCUITS

The applicability of the King system of coupling variation in the circuits previously referred to is immediately apparent. Considering again the first of four familiar propositions, the movable coil would be the antenna primary with the condenser shunted across the secondary or stationary coil.

In the regenerative circuit, the moving coil is, of course, the tickler, and the large inductor, the grid coil tuned by the condenser. As already suggested, the interaction between the tickler and tuning control is automatically compensated. A simple three-circuit regenerative receiver of this type would be admitted to the best of radio society. It is a single-control set, with automatic regeneration necessarily prevented from spilling over and radiating at any frequency. This receiver will be considered in detail in a later article.

In the Superdyne arrangement the moving coil is the reversed tickler, eliminating one control from this excellent receiver. In tuned r.f. systems, the moving coil is the primary or output coil of a preceding tube. The controlling condenser is shunted across the secondary inputting to the succeeding tube. The construction of a five-tube receiver of this type will be described in an early number of Radio Broadcast.

Radio Broadcast Photograph

FIG. 6

Constructional view of the essential parts of the system. From left to right we have a stationary coil with mounting bracket, a condenser extension shaft, a movable coil arranged for simple mounting, and a more elaborate moving coil device mounted on an extension shaft. Either type of movable coil may be used as secondary. The type at the extreme right is more elaborate, merely

How to Get the Most Out of Your Super-Heterodyne

Results of an Extended Laboratory Analysis of the Best Practise in Super-Heterodyne Construction and Operation—Instructions for Most Efficient Treatment of Each Section of the Receiver

By KENDALL CLOUGH

Director, Research Laboratories of Chicago, Inc.

WHILE many circuits have come and gone in the art, the super-heterodyne has consistently attracted the home builder and experimenter. This is rightly so because of the field of endeavor yielded by this circuit, embodying as it does, most of the fundamentals of radio engineering. The only regrettable angle in the development of this receiver along with the art is that it has appeared colorful to the barn-loft type of engineer, who in many cases has taken a standard circuit, cluttered it over with trick dials and freak knick-knacks until many of their products can scarcely be conceded to be radio sets, let alone super-heterodynes.

So many beautiful principles are involved in this circuit that in its simplest form it has presented a fruitful field of endeavor for four months of intensive research in a commercial laboratory, in an effort to determine for the experimenter which of this or that is best and to find plausible remedies for some of the glaring defects in receivers already constructed. While it was our original intention to embody these ideas in a complete constructional article, this plan miscarried and the results are being presented in such a way that those who have already built super-heterodynes may be afforded some means of improving them and locating defects in their design, it is hoped. So much has been said on super-heterodynes relative only to particular receivers or by those whose authority is to be questioned rather than respected, that it seems no more than just to tell the reader how the statements to be made in regard to the various components of the super-heterodyne were arrived at. In every case, the theory of the portion of the circuit in question has been carefully considered and checked by qualitative measurements on the laboratory bench and the results applied to a variety of receivers. In the net, we have attempted to make the results of such investigations applicable to as large a variety of receivers as possible, as well as to specific receivers to be presented to the readers of RADIO BROADCAST on a future occasion.

The most feasible method of treating the receiver will be to break it up into component parts as shown in Fig. 1, and consider them separately with respect to receiver as a whole.

ATTAINING GREATER SELECTIVITY

AS A collector, the short antenna with antenna-coupler has proved itself far superior to the loop. The latter's only claim to superiority is its directional effect which is considerably mitigated in the city by reflections from steel buildings, etc. It has a further disadvantage in that its physical proportions do not allow of an adjustment of coupling or absorption from the progressing wave front of the signal. The desirability of this feature will be pointed out in connection with the intermediate amplifier, as it follows some of the theory of that equipment. The unpopularity of the antenna coupler may be attributed to the fact that it has been recommended and used with such large antennas. This procedure will ruin the apparent selectivity of any super-heterodyne; from ten to thirty feet of wire in the same room with the receiver will provide all the pickup needed for a well designed set.

It is pretty generally known among heterodyne fans that the selectivity of a super-heterodyne may be improved in the intermediate amplifier only to a certain point; beyond that, the quality of reproduction is seriously impaired due to the cutting of the side bands of the carrier frequency. The remainder of the selectivity problem remains in the collector system. Obviously then, the antenna coupler and its condenser must have as low effective losses as possible. The construction of coils to yield low resistance has been so thoroughly treated in these and other pages that it is not necessary to review them here. The constructor need only be certain to use a coil and condenser which *are* low loss and not which are merely *said* to be low loss.

A further advantage of the antenna coupler is that it allows of a circuit arrangement which does away with body capacity on the tuning and regenerative condensers as is pointed out in Fig. 2. Note that both rotors are connected to the A battery.

The first detector has a function which is purely as its name implies, one of detection: hence it should be as sensitive as possible. Of the two methods of detection, condenser and leak, and by C battery, the former is to be preferred as it yields somewhat greater sensitivity than the C battery type. In many cases an improved result will be obtained by careful selection of tubes, value of grid leak and condenser, using always a weak signal for comparative purposes.

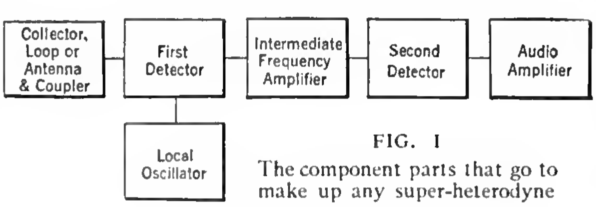


FIG. 1

The component parts that go to make up any super-heterodyne

It is often asked which of the two arrangements shown in Fig. 3 is more desirable. Briefly, we have not been able to establish any superiority of one over the other, save that (b) allows mounting the tuning condenser directly on the shield.

If the reader desires to make the corresponding portions of his circuit conform to this article, it is suggested that he select his equipment as outlined and insert a pair of phones shunted by a 0.005-mfd. condenser at x, Fig. 2. In this way he may tune-in local or near-by stations as on an ordinary regenerative receiver and make his selection of tubes, condensers, and leaks.

The feedback coil L-2 should be wound at the filament end of the secondary coil L-1 and of a sufficient number of turns so that the tube will go into oscillation near the maximum capacity of C-2, when C-1 is set at maximum. If any difficulty is found in bringing this about it will aid to insert a small r. f. choke in the circuit as shown in Fig. 2. This will prevent the first transformer from short circuiting the plate circuit, from a radio frequency standpoint. Such a choke may consist of one hundred turns of No. 34-38 wire on a 1-inch tube.

In view of the fact that we want perfect control over the amount of energy coupled into the receiver from the antenna, we must have the first detector unit shielded to prevent the coil from picking up signal energy other than that supplied it by the variable coupling coil L-3. The shield should be a well-constructed copper or aluminum can of sufficient size to accommodate the equipment with generous clearance around the coupler. All joints in the can should be lapped or soldered, and leads brought through the smallest holes possible. A pair of leads made of thickly insulated wires twisted together lead out of the shield to the oscillator pick-up coil.

The ideal super-heterodyne oscillator will embody certain qualifica-

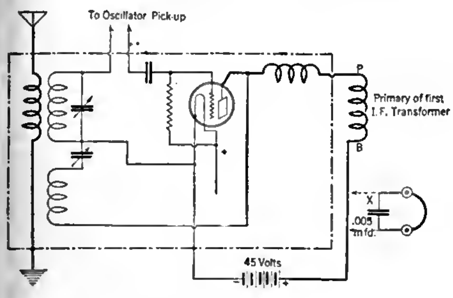


FIG. 2

The first detector of a super-heterodyne using regeneration. With this circuit arrangement there is no bothersome hand capacity because both of the condensers are at ground potential

tions met by very few to date. First, it will radiate no power save that fed out to the first detector from the pickup coil. This entails shielding in a carefully made copper or aluminum can. It also requires the use of a 1.0-mfd. condenser as shown in Fig. 4 and a choke in the battery lead to prevent the generated radio-frequency current from coupling with other parts of the receiver in the B battery and battery leads.

The shield also minimizes radiation to neighboring receivers. From the conditions in metropolitan districts, we should judge that few are altruistic enough to consider this an important point. Taking a selfish view of the thing, however, it does mitigate the possibilities of a neighboring "blooper" from mistaking your oscillator carrier for that of a distant station, thereby introducing an interfering heterodyne in your own reception.

It should be noted in Fig. 4 that only the grid circuit of the oscillator is tuned. This permits the shaft of the condenser to be grounded, eliminating "hand effects" so troublesome when the rotor is connected to the plate. Under proper conditions, the tuned grid type is subject to less trouble from harmonics.

In the metropolitan districts particularly, the presence of harmonics in the local oscillator output becomes troublesome. Their presence is indicated when in attempting to tune-in a distant station on a long wave (425 to 550 meters) a local station on a short wave is heard. In such cases, the second harmonic of the local oscillator is actually heterodyning the short-wave signal which is sufficiently strong to get through the input tuning device. A further effect is an apparent broadness of tuning on all near-by stations.

Presence of strong harmonics in the local oscillator causes stations to be tuned-in at several points on the dial.

This action may be explained as follows. Assume that an intermediate frequency of 45 kilocycles is used and that reception from a 600-kilocycle station is considered. In this case it would be necessary to supply a local heterodyne frequency of 645 kilocycles. Let us further assume that with the oscillator in question this frequency is at a dial setting of 80 and that the frequency varies with dial setting at a rate of 10 kilocycles per dial division.

Along with the fundamental the 600-kc.,

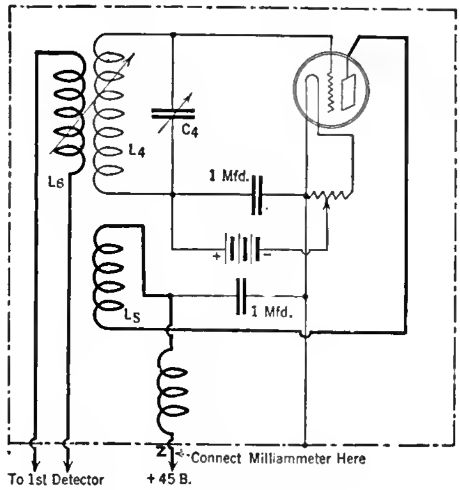


FIG. 4

The oscillator. Only the grid circuit is tuned so that hand capacity on the oscillator dial is eliminated. A positive bias is used on the grid to minimize the even harmonics generated by the oscillator

the station emits a second harmonic of 1200 kilocycles. Obviously a frequency of 1245 kilocycles which may be supplied by a harmonic of the local oscillator will heterodyne the 1200-kc. harmonic. The fundamental of the oscillator while supplying

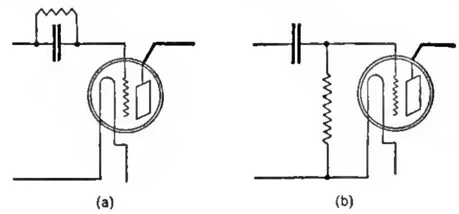


FIG. 3

Two methods of connecting the grid leak and condenser into the circuit. Results are the same with either arrangement

this frequency will be $\frac{1245}{2} = 622.5$ at a dial setting of 82.25.

In the same way it may be shown that another heterodyne action due to the third harmonics of the station and oscillator will be present at a dial setting of 83. Thus a strong local will have as many heterodyne points as there are harmonics.

The table A is illustrative of the foregoing.

If the intermediate amplifier is sufficiently selective there will be definite peaks on the dial at the points mentioned. If not so selective the dial settings mentioned will merge and cause the whole receiver to appear hopelessly unselective.

The generation of these harmonics is due to the curvature of the characteristic of the oscillator tube. Examination of the theory of the oscillating tube indicates that if such an adjustment of the oscillator circuit can be arrived at that the plate current will be the same in or out of oscillation, then the even harmonics will be minimized or even deleted. Since the interfering harmonic usually found troublesome is even (the second) it will be handled by this procedure.

Peculiar as it may seem, the 201-A type of tube requires a positive grid bias of 9 to 15 volts to bring this condition about. It might seem on first thought that the oscillator drain would be excessively increased by such procedure. Such is not the case, however. In a representative case in which this principle was applied (201-A tube with 45 volts B battery) the plate current measured 10 milliamperes with the tube oscillating and zero grid potential. When the necessary positive grid bias was employed (11 volts), the plate current increased to only 13 milliamperes. In this same case the amplitude of the second harmonic was found to be reduced to 8.2 per cent. of its original value.

The application of this principle to the circuit of Fig. 4 is

High-Lights on the Super-Heterodyne

Detector

"As a collector, the short antenna, with antenna coupler, has proved itself far superior to the loop."

"For the first detector, grid leak and condenser detection is to be preferred as it yields somewhat greater sensitivity than the C battery method of detection."

"The first detector unit should be shielded to prevent the coil from picking up signal energy other than that supplied by the antenna coupler."

Oscillator

"The ideal super-heterodyne oscillator will radiate no power save that fed out to the first detector from the pick up coil."

I. F. Amplifier

"It seems almost entirely out of the question to use frequencies in the vicinity of 30 kilocycles."

"If the intermediate frequency is any integral multiple of 10 kilocycles (30–40–50–etc.) there is grave danger of one station heterodying another to your intermediate frequency, without the use of the local oscillator."

"The whole heart of the I. F. amplifier problem, after the selection of the proper frequency, seems to be in the proper matching of the transformers and filter."

"The super-heterodyne fan cannot take iron-core transformers, advertised to be equally efficient over a broad band of frequencies, and associate them with a filter tuned to any frequency in the band and expect to obtain best results."

"Unless shielding is made prohibitively large for the I. F. amplifier, the matching of the transformers is affected by its presence, which more than offsets any improvement by virtue of the shielding."

Second Detector

"C battery detection, in the second detector is better."

"Provided all the tubes are in good condition there is little or no need for separate rheostats on any of the tubes."

very simple for the broadcast experimenter. With an oscillator connected as shown in Fig. 4, a milliammeter is connected into the circuit at the point Z. If a milliammeter is not at hand, a low reading voltmeter of good quality, such as is used to test the storage battery, will usually serve the purpose. Now with the oscillator set near the upper end of the scale (500 to 600 meters) a trial value of C battery is inserted and the meter reading noted. The tuning condenser is now short circuited and the reading again noted. If the latter reading is lower than the first the C voltage should be increased and vice-versa. A potentiometer is shown in Fig. 4 across the filament terminals to facilitate this adjustment. After the correct value of C battery is found, the reading of the meter at Z will be unchanged by short circuiting the tuning condenser. If this adjustment cannot be arrived at with a convenient value of C battery and the tube kept oscillating, it may be necessary to alter the number of turns in L-5. Here persistence will be well rewarded, if you are bothered with the type of interference mentioned.

TABLE A

Strong harmonics in either the wave transmitted by the broadcasting station or in the wave generated by the oscillator will make it possible to tune-in a single station on as many points on the dial as there are harmonics. This table shows how. The distant station on 600 kc. can be tuned-in at three points due to these harmonics.

Distant Station	Local Oscillator	Local Station	Oscillator Dial Setting	Beat Note
600 Kc. (Fundamental)	645 Kc. (Fundamental)	——	80	45 Kc.
——	1290 Kc. (2nd Harmonic)	1245 Kc. (Fundamental)	——	45 Kc.
600 Kc. (Fundamental)	——	——	——	——
1200 Kc. (2nd Harmonic)	1245 Kc. (2nd Harmonic of 622.5 Kc.)	——	82.25	45 Kc.
1800 Kc. (3rd Harmonic)	1845 Kc. (3rd Harmonic of 615 Kc.	——	83	45 Kc.

WHAT TO DO ABOUT THE INTERMEDIATE AMPLIFIER

IT IS customary to start discussion of the intermediate amplifier by stating what intermediate frequencies are best. It appears more logical in this case to state what frequencies are poorest. It seems almost entirely out of the question to use frequencies in the vicinity of 30 kilocycles. The writer has so far examined no transformers of this type that were not fairly effective down into the audio range with the results that the amplifier is inevitable noisy and unselective. Several transformers are available operating from 40 to 60 kilocycles which are generally more satisfactory if properly selected. In this group, however, there are several frequencies that are eminently undesirable.

Under the present system of allocating wavelengths, our broadcasters are 10 kilocycles apart. Each station is radiating not only its fundamental frequency assigned. but in most cases several harmonics or multiples of this frequency. This being the case, it is a simple mathematical demonstration, and we have proved it time after time in practice, that if the intermediate frequency is any integral multiple of 10 kilocycles (that is 30-40-50-60, etc.) there is grave danger of one station heterodyning another to your intermediate frequency without the use of the local oscillator. If you are already the possessor of a super-heterodyne you may check this condition by simply removing the oscillator tube and tuning slowly with the loop condenser at a time when the majority of your locals and semi-locals are on. If you can tune-in stations in this manner (they usually come in pairs), your intermediate amplifier is operating at or near one of the frequencies mentioned and should receive attention before attempting to improve the receiver by any other measures. Thus we may conclude that the best operating frequencies in the range mentioned are those values lying close to 45, 55, and 65 kilocycles.

The whole heart of the r. f. amplifier problem, after selection of the proper frequency, seems to be in the proper matching of the transformers and filter. Mismatching of these units is a deterrent to both selectivity and amplification. In view of the importance of the subject, a long study was devoted to it.

It has long been an established fact in electrical engineering that the inductance of a coil having an iron core, or with iron in its field, varies with the voltage impressed across the coil. This phenomenon is due to the fact that the permeability of iron and steel varies with the number of lines of magnetic force set up in the iron. While the phenomenon is an old one in low frequency practice, it was immediately wondered if the same laws regarding this variation held at high frequencies, say, 30 to 75 kilocycles, especially because the better transformers now on the market and designed to operate at these frequencies, contain more or less iron.

To make a long story short, these laws did hold. In fact, it was found that on setting up a representative stage of amplification, that is, a tube and transformer of a certain type, that on impressing voltage of the order of one-half to one volt on the tube, the best operating frequency of the transformer was a great deal different from that obtained when voltages of the order of one to five-hundredths of a volt were impressed on the tube. As a specific example, with one type of transformer tested, we found that an input of half a volt showed an apparent best operating frequency of 60 kilocycles, whereas with an input voltage of two-hundredths, the best operating frequency of the transformer was found to be 43 kilocycles.

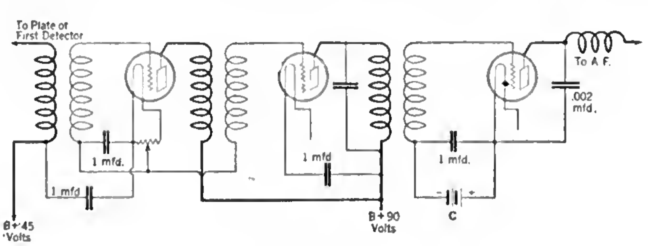


FIG. 5

The intermediate amplifier and second detector. By-pass condensers are used to prevent undesired interstage coupling. For most satisfactory control of the I. F. amplifier, it is sometimes necessary to place a small C battery bias on the first amplifier tube

I. F. TRANSFORMERS HAVE BEEN IMPROPERLY TESTED

IN THE usual operation of intermediate-wave transformers in practice, the voltage impressed on the amplifier tube has been found to be at the order of a few hundredths of a volt, rather than the larger values used by most manufacturers in their testing and matching operations. In view of this fact, it seems only reasonable that input or output transformers for intermediate-wave use should be designed and adjusted to the frequency of the transformers when tested at extremely low voltage. These laboratory experiments were substantiated in practice by using two of the transformers mentioned with a 60-kilocycle filter, with the result that local stations were brought in with extraordinary volume, and out-of-town stations with a rather mediocre output. In changing to the 43-kilocycle filter, out-of-town stations were doubled and even trebled in volume, while the intensity of local signals actually fell off, due to the tendency of the high input voltages from the local signals tending to throw the transformers out of tune with the filter. This effect was also substantiated by an extended series of experiments with completed amplifiers, measuring the input and output voltages at various frequencies with the tube filters.

A further point came to light regarding the character of the intermediate iron-core transformer, which was that each such transformer while apparently very broadly tuned when using high input voltages, showed very decided resonance or peaking characteristics when tested on small inputs, due, no doubt, to the lower losses induced by the iron at these lower densities. As a practical result, this means that the super-heterodyne fan cannot take iron-core transformers, advertised to be equally efficient over a broad band of frequencies, and associate them with a filter tuned to any frequency in that band, and expect to obtain the best results. Such results can be obtained only by finding the actual peak of the transformers, at low input voltages, and then using a filter of the same frequency.

The construction and calibration of a test set to perform these measurements at low input voltages is more of an expense and undertaking than the average experimenter would care to go to. In view of this fact, the equipment has been made available to several manufacturers who, we understand, are making the use of it available to experimenters at a nominal fee. In applying for matching service the experimenter should ascertain that the testing is done at low input voltages and state what type of tubes the transformers are to be used with, as the matching changes considerably with change of tubes.

After careful matching of the transformers and filters they must be installed in the receiver so as to conform to the methods used in matching. Grid and plate leads should be as short as it is possible to make them. The 1.0-mfd. condensers shown in Fig. 5 should be located as close as possible to the transformers to prevent long battery leads from ruining the calibration of the transformers.

With carefully matched transformers of high quality there is little point in using more than two stages of intermediate amplification. Two stages will get down to the noise level in most localities after which added amplification adds nothing to the effectiveness of the receiver.

CONTROLLING AMPLIFICATION

FOR the control of the amplification, the writer has found nothing more effective than the old fashioned potentiometer. It has the advantage of being the only system tried which does not change the calibration of the transformers to any extent. This by the way, brings up a point in connection with shielding of the i. f. amplifier. This has only the advantages of shielding against pickup of long-wave signals and a possible improvement of the cascade amplification of the system. The former reason has never been much of a factor in most localities and the second has been found futile by numerous measurements on long-wave transformers of various makes. In the latter case, unless the shielding is made prohibitively large, the matching of the transformers is affected by the presence of the shielding material, which more than offsets any improvement by virtue of the shielding.

The principal difficulty experienced with the intermediate amplifier is that of inselectivity. This may be due to several causes. Mismatching of transformers and filters is the most flagrant and has been treated previously. The second is the use of transformers with too flat a characteristic. Under present conditions it is not feasible to depend entirely on the filter for selectivity. The transformers themselves must offer a certain degree of selectivity before the signal reaches the filter transformer.

A further source of difficulty has been termed by the writer a "splashing" effect. It is the effect of shifting peak referred to above in connection with transformer testing. Powerful local signals have a tendency to shift the operating wavelength of the transformers. This can be coped with only by loosening the antenna coupling or shortening the antenna to the point where the effect ceases, without sacrificing too much in the way of volume on distant stations.

For the sake of unity the second detector has been embodied with the amplifier in Fig. 5. C battery detection here is better than the grid leak and condenser method for several reasons. In the first place it is quieter in operation than the condenser and leak and results in better audio output with most amplifiers. The principal reason is because of the effect of the condenser and leak type detector on the output filter. Most filters now on the market are impaired by the use of a shunt resistance across their secondaries. In view of the fact that the grid leak in the grid detector must be connected to the positive end of the filament, the grid of the tube will attract electrons, causing the input of the tube to be of the nature of a resistance across the filter. For this reason the C battery detector inevitably results in better selectivity in the filter. So little has been said with regard to the proper value of C battery that the curves of Fig. 6 were made. They indicate that the proper value of C battery for the various tubes and voltages, are as follows:

TUBE	B BATTERY	C BATTERY
201-A	45 volts	3 – 4½
201-A	90 "	8½–10½
199	45 "	6 – 8
199	90 "	16 – 18

These curves also show that slightly better response is obtained with either tube operating at 45 volts than with 90 volts.

So much has been published in RADIO BROADCAST with regard to audio amplifiers that we will not repeat here save to call attention to the choke coil L and the 0.002-mfd. condenser in Fig. 5. The choke should consist of 1500 turns of fine wire wound on a 1-inch spool. Both choke and condenser should be located as close as possible to the output of the intermediate amplifier with which they are associated. They are not a part of the audio amplifier and serve rather to isolate it from the receiver.

We mentioned previously the necessity of variable coupling in the antenna coupler. In a receiver constructed in accordance with the above ideas it should be possible in metropolitan districts to decrease the coupling to the point where the local stations will appear very sharp and well defined with plenty of room on the dials for out-of-town reception. This coupling is very critical and is usually just short of the point where the volume falls off on distant signals. If it cannot be attained, then reduce the size of the indoor antenna to some extent until proper selectivity is obtained.

It is hoped that the above ideas have been presented in such a way as to be helpful to those building new receivers or in reconstructing old material. Every effort has been made to present ideas which are in keeping with sound engineering practice, and we hope will be of some assistance to the experimenter who is already fed up on unfounded hokum.

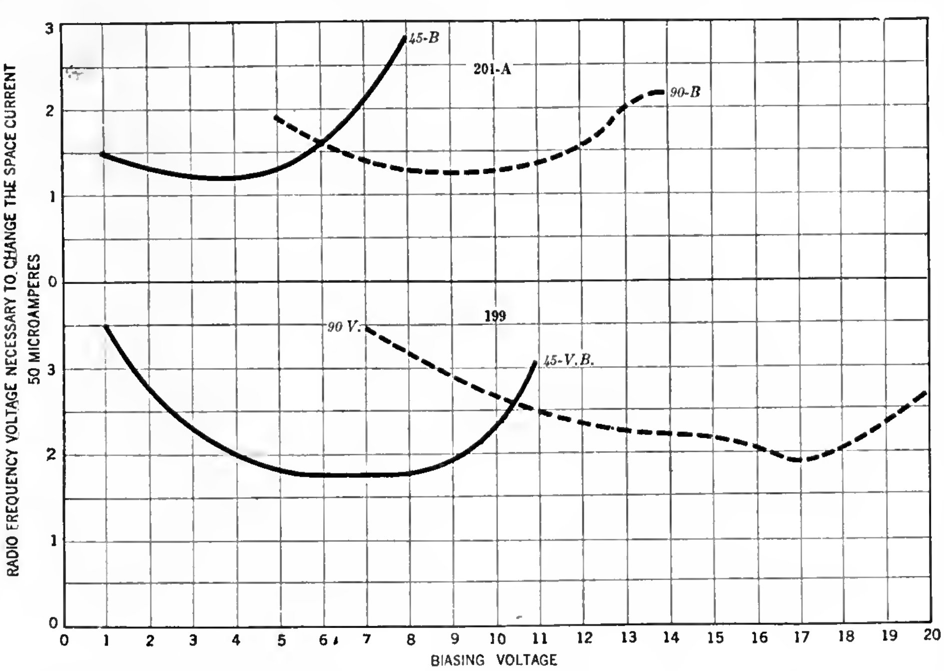


FIG. 6

Response curves of a C-battery detector for different values of plate voltage and C battery. The grid and plate voltages that give a change of 50 micro-ampers in plate current, with the smallest radio frequency voltage, are the best to use. From the curves it can be seen that best response is obtained with 45 volts on the plate of the tube and a C battery of approximately 3½ or 4 volts

RESULTS OF THE SHORT-WAVE RECEIVER CONTEST

Description of a Contest Receiver Submitted by Frank C. Jones—A Simply Built and Operated Set Which Radiates Far Less Than Standard Amateur Receivers

As a feature of the Radio Broadcast-Eveready short-wave experiments conducted in the short-wave experimental laboratory of Radio Broadcast at its station 2 GY a contest was announced, in February, 1926, open to all, in the hope of inspiring some able amateur to bring forward the design of a non-radiating short-wave receiver. During the early days of broadcasting, when the radiating regenerative receiver was at the height of its popularity, Radio Broadcast took the then revolutionary step of barring from its pages, the advertising and constructional description of receivers which radiated. That policy has been maintained, as far as broadcast receivers are concerned, to the present day.

In the short-wave amateur field, however, the radiating receiver—the only type in use by the thousands of amateurs who fill the bands assigned to them—has not brought about the same widespread condemnation as has its use in the broadcast range. Feeling that the work of the amateurs could be greatly improved by a wider use of a sensitive receiver which would not radiate, a prize contest for such a design was arranged by Radio Broadcast.

About fifteen manuscripts were selected for consideration out of all those submitted in the contest. Exhaustive tests conducted at 2 GY showed that all of the receivers submitted by contestants did radiate—especially those that actually received signals. To determine those which radiated the least, the following tests were made. In station 2 GY, a standard Reinartz receiver is in use. By keying the plate circuit of this receiver, code was transmitted to another receiver in the office of Radio Broadcast, some 400 yards away. Later, when a microphone was placed in the ground lead of the Reinartz, speech was readily understandable at the office. The contest receivers were compared to this set. Those which radiated as badly were at once eliminated.

It soon became apparent that not one of the surviving group of the contest receivers satisfied the conditions of the contest. With the permission of the judges, Boyd Phelps, Prof. L. A. Hazeltine, Zeh Bouck, G. C. Furness, Arthur H. Lynch, Edgar H. Felix, Dr. Lawrence Dunn, Prof. J. H. Morecroft, and Dr. A. Hoyt Taylor, and the designers of the receivers which came nearest to satisfying the conditions, it was decided to award $100 to the designer of the receiver which radiated the least and which was, at the same time, sensitive.

The set described in the accompanying article has been given the $100 award, and its designer is Frank C. Jones, operator of station 6 AJF of Berkeley, California. This set is not as sensitive as a Reinartz, and a second audio amplifier should be added which will bring it up to equality with a Reinartz. Mr. Jones's receiver radiates far less than the Reinartz, and under actual test for a number of months in our Laboratory, more stations were heard on the set than can be "worked" by the average transmitter. We feel that Mr. Jones has described an interesting circuit, simple to construct and certainly as simple to operate as the conventional amateur radiating set.

We are frank to admit that the set described does radiate slightly, that it is given an award, not the $500 prize as originally planned, in spite of the fact that the main condition of the contest was not completely met. Radio Broadcast believes it is performing a greater service in making public this design, which has much in it to inspire other experimenters to work along similar lines, than by refusing to give currency to *any* of the interesting designs. Several other ingenious circuits were submitted. Two using push-pull detectors intrigued the Editors greatly, but the transportation company wrecked both of these sets twice. It is still hoped that these sets may be received at 2 GY in good condition. Much of the delay in deciding this contest was due to the complications caused by damaged sets.

It is hoped that this article and others to follow will help experimenters to develop a really non-radiating short-wave receiver. Dr. A. Hoyt Taylor. the famous short-wave experimenter, has written us: "It is entirely possible to make a receiver which will not radiate, no matter how sensitive it is, provided that proper principles are applied. It must be admitted, however, that the method employed to suppress radiation will naturally run up the cost of the receiver. It does seem rather strange that no one has been able to produce a receiver which will completely suppress the radiation. The problem is by no means impossible of solution, nor is it too difficult for a high grade amateur to attempt." At eighty meters it is entirely possible to build a neutralized radio frequency amplifier and transmitting stations using master oscillation systems use neutralized amplifiers as low as fifteen meters.

The editorial pages of Radio Broadcast will always be open to the "high grade amateur" who can produce such a receiver.

—The Editor.

How to Build and Operate the Jones Receiver

By FRANK C. JONES

Amateur Station 6 AJF

All of the ordinary short-wave tuners in use at present radiate energy to some extent, which is rather undesirable, especially in cities where a number of short-wave receivers are likely to be in operation. Any one can check up on that by listening to all the little chirps as someone swings his oscillating receiver across your wave a few times, even though the owner of the set may be some distance away. There are several ways of lessening the radiation from a short-wave tuner such as using a stage of neutralized radio frequency or a blocking tube ahead of the oscillating detector, or by using very loose coupling to the antenna. These all have their disadvantages. Perhaps it is an extra tuning control, or an extra tube or insufficient coupling to the antenna. After all, these expedients do not fully accomplish the desired result, the elimination of radiation from the oscillating tube. In the receiver described here, radiation is practically eliminated if proper care is taken in making the final balance adjustments.

The circuit of this receiver is shown in Fig. 1, and as can be seen, there is nothing startlingly new about it except that the principle of the Wheatstone bridge is employed in the circuit. An analysis of the circuit brings it down to the familiar bridge circuit as shown in Fig. 2. The tuning inductance L_2 is tapped in the exact center and forms the inductance arms of the bridge while C_3 forms one of the other legs which must be made equal to C_4 in order that no potential will exist between points A and B or across L_2. C_4 is the grid-to-filament capacity of the oscillating detector tube plus other small capacities due to location of the wiring and the grid condenser, etc. The fixed tickler is placed at the center of L_2 so that equal voltages are induced across the two halves of L_2. If the bridge is balanced, no current will flow through L_3. which corresponds to a galvanometer or a telephone receiver in the ordinary form of the Wheatstone bridge. Since the antenna

Facts About the Receiver

Type of Circuit = Modified Wheatstone Bridge Principle.
Number of tubes = 2 tubes = 1 regenerative detector plus 1 audio-frequency amplifier.
Type of tubes = 201A's throughout.
Frequency bands = 17,640 kc. to 1764 kc. (17 to 170 meters).
Type of Antenna recommended = Pickard Horizontal Antenna; any other type satisfactory.

system is connected across L3, no radiation occurs from the oscillating tube into it—which is the long sought for result.

When a voltage such as an incoming signal is applied across points A and B of Fig. 2, there is zero voltage across points E and D, and if the detector tube had its grid and filament leads to E and D, no signal would come through the tube circuit. However, the grid is connected to point E and the filament to point B so that there is an actual voltage across it. The voltage due to the incoming signal voltage drop across L3, splits at A and B through the two halves of the circuit so that the maximum amount impressed across the grid and filament is half of the total signal, while the other half is lost or dissipated through C3, and the other half of L2. This is of no practical concern, since a little larger receiving antenna, or closer coupling to the same antenna as used with one of the common types short-wave tuner, will bring the signal strength back to normal. Actually, with this system it is possible to get greater coupling to an antenna without causing the tube to stop oscillating, than with most other receivers due to the balanced system used in it.

The effect of the tuning condenser C2 on the circuit is merely to increase the effective inductance of L2 in one sense of the word, and has no effect on the balance of the bridge, since it is across points E and D of Fig. 2. Since interchangeable coils are used in order to cover the amateur bands of from 15,000 kc. to 1500 kc., (below 20 meters up to 200 meters), the center taps on the coils should be at the exact center and the tickler coil should be fastened quite rigidly in the center of each of these coils. This eliminates resetting the small condenser C, each time the coils are changed, since the "effective" value of C4 is about constant.

DETAILS OF THE RECEIVER

THE actual tuner itself is subject to a number of modifications. No one ever makes a short-wave tuner exactly according to specifications, so no rigid rules are given. The pictures of the set give the general panel and baseboard layout. The set was built for the new UX tubes. Rubber sponge cushions are glued to the UX sockets and to the baseboard. The cushions are quite effective in eliminating ringing sounds due to vibration. Microphonic noises are especially troublesome when one is tuning on the higher frequencies. Automatic filament control is obtained by the use of Amperites which work quite satisfactorily and eliminate one or two controls. Twenty-two volts are used on the plate of the detector tube and 90 on the audio stage.

The front panel can be a 7" x 12" or 6" x 12" bakelite or hard rubber panel, while the rear panel supporting the condensers should be of hard rubber and about 4" x 9".

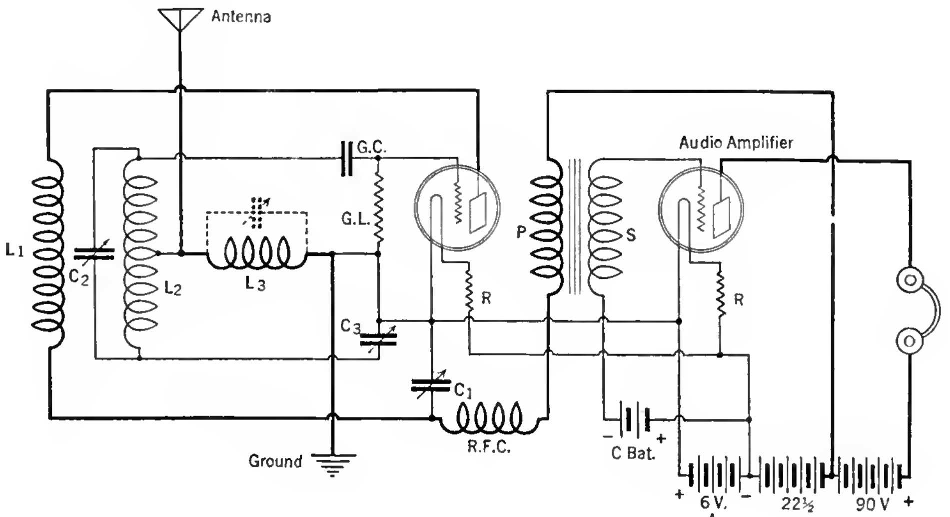


FIG. 1
The circuit diagram of the short wave receiver described in this article. It looks complicated but really is quite simple

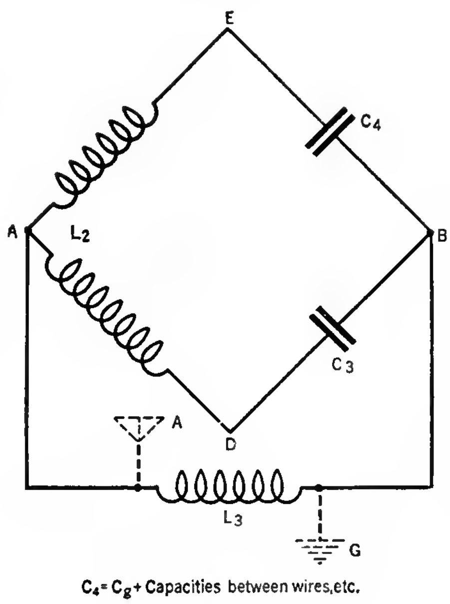


FIG. 2
The equivalent bridge circuit of the input part of the circuit shown in Fig. 1

It is necessary to have the panels quite rigid since extension shafts are used on the condensers. In this receiver, three brass "angles" or box corners were used on each panel to fasten it to the baseboard. In the front panel is a filament snap switch and an open circuit jack for the telephone receiver plug. Each of the two condenser extension shafts terminate in a 4-inch dial, the one on the tuning condenser C2, having a Tiny Turn vernier, which gives a 40 to 1 ratio with a very smooth and noiseless control for fine tuning. A good vernier is very important. The other dial which operates the "throttle" of feed-back condenser is unimportant and could as well be a knob as the regeneration control C, has practically no effect on the tuning condenser C2.

The rear panel should be far enough from the front panel so that the effect of hand-capacity while tuning will be nil. If the space between the panels is about 7 or 8 inches, that will generally be sufficient. The two large variable condensers C2 and C1, of approximately 0.00015- and 0.0002-mfd. respectively should be mounted on the rear of this panel and the rotor shafts connected by means of insulating fibre bushings to the extension shafts and dials. These bushings were made of 2" lengths of fibre tubing with a ¼" bore and were drilled and tapped for 6/32 machine set-screws near the ends. The writer believes that it is much better to use extension shafts than to use metal shielding in any kind of short-wave receiver construction. That point is especially important in this circuit where every small capacitance is important when balancing the circuit, as a bridge. The tuning condenser C2 should preferably be of the straight-line frequency type, or be a model where the plates are trimmed, and should also preferably be of a skeleton construction in order to have a low minimum capacity.

The grid condenser of 0.0001-mfd. or smaller should be of the best and can be conveniently mounted on the back panel. The grid leak should be from 6 to 10 megohms and a "quiet" one if it is possible to obtain such a thing. The balancing condenser C3, was also mounted on the back panel using a small bracket. This was a midget condenser of about 0.00003-mfd. maximum and a low minimum capacity and after it is once set it can be left alone.

RADIO BROADCAST Photograph

FIG. 3

Coils for the receiver, which include the inductance used in the tuning circuit, and the fixed regeneration coil situated in the center of the tuning inductance

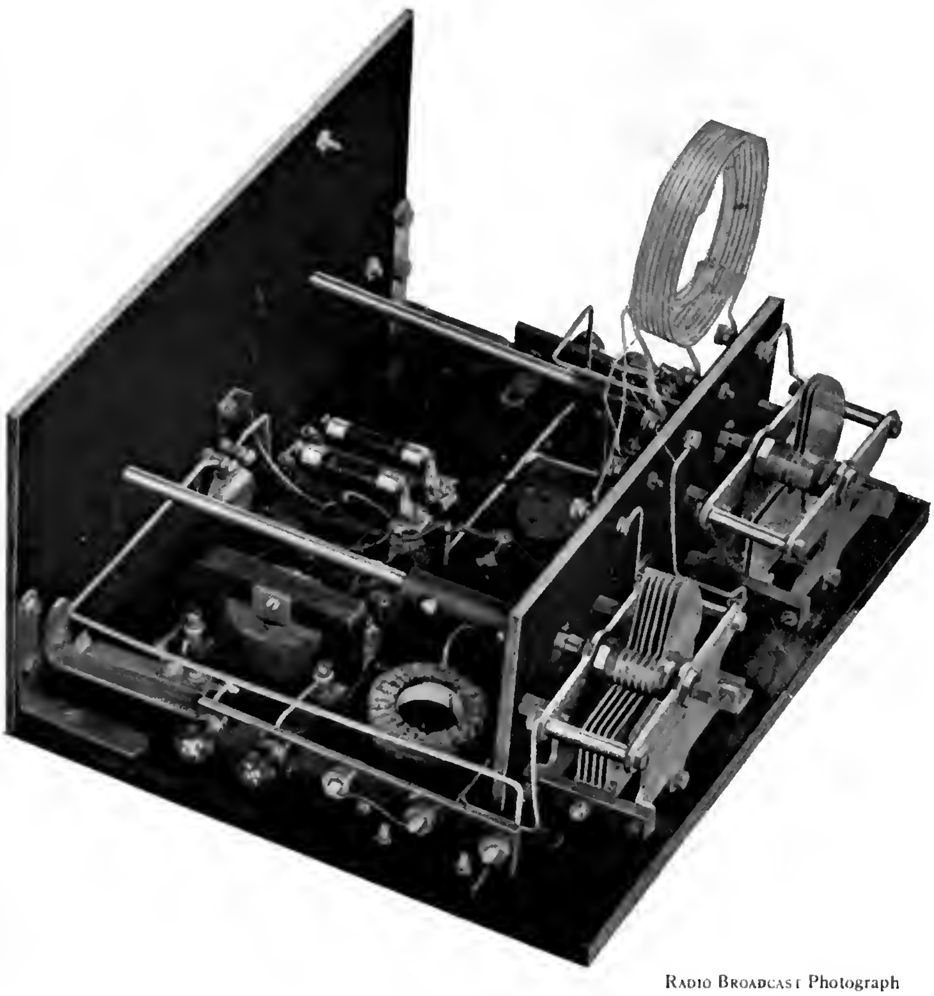
THE IMPORTANT ANTENNA CIRCUIT

LEADS for the inductance L3 were brought out to binding posts on a small hard rubber strip. This was done so that the coil L3, could be placed a foot or two away from the rest of the tuner. It is the voltage drop across this inductance that is impressed on the arms of the bridge and so on the grid of the detector, which means that for maximum drop the antenna circuit including L3 should be tuned to resonance with the incoming signal. This generally means too much coupling, similar to bringing the primary coil of an ordinary tuner tight up against the secondary coil, so it is best to tune the entire antenna circuit to some frequency (wavelength) just below the range of the tuner such as 1492 kc. (201 meters). An easy way to tune this circuit to some such frequency is to set the shunt condenser, shown in dotted lines in Fig. 1, just below the setting for a near-by broadcasting station whose frequency is around 1500 kc. (200 meters). For instance, if the local station was on 1440 kc. (208 meters), and it was possible to hear it with the detector not oscillating and the L shunt condenser set at 25°, setting the condenser at about 20° should fix it about right. This arrangement gives a pretty good voltage drop across the coil L3. for all frequencies above 1500 kc. (below 200 meters), and is better than using, say 3 or 4 turns which would give very little "coupling" on the higher amateur bands. The coil L3 depends on the antenna used and may be anything from 5 up to 30 or more turns. By using the new horizontal type of receiving antenna described in *QST* for February, 1926, by Dr. Greenleaf Pickard, very excellent results are obtained. This type of antenna is very inefficient for longer wavelengths, such as those used by broadcasting stations, and extremely efficient for short waves. A horizontal wire 75 to 100 feet long with the coil L3 and its shunt condenser inserted in the center certainly works fine when tuned to 1492 kc., (201 meters) and left at that adjustment.

At least one stage of audio frequency is necessary and a high ratio transformer may be used to advantage. The radio-frequency choke coil which taps on to the feed-back condenser should be small so as to have a small field and should be wound for minimum self-capacitance. A small honeycomb coil such as is used in certain superheterodyne transformers is very good or one can be wound on a $\frac{3}{4}''$ wooden form with finishing nail pegs. The best way of obtaining such a coil is to show the wife how fascinating it is to weave the pretty green silk covered wire in and out around the pegs on the coil form. That system worked excellently in the writer's case and produced a nice 500-turn miniature honey-comb coil at his station, 6 AJF.

HOW TO MAKE THE COILS

THE tuning coils, L2, are made of spaced windings with a 3-inch diameter. A 3-inch cardboard tube was used and four narrow celluloid strips tied down with string around the circumference of the tube. No. 16 d.c.c. wire was used on the smaller coils and No. 18 d.c.c. wire for the larger ones. The turns were spaced about the diameter of the wire or slightly less while winding it on the tube. Winding the coil is really quite simple, providing that the wire is free from kinks. The coil can be wound in a very short time. After fastening down the ends of the coil, collodion, or a solution of acetone with celluloid dissolved in it, is applied along the wire above the strips of celluloid which then dissolve slightly, letting the wire sink into it a small amount. When the coil is thoroughly dry, these celluloid strips hold the wire very firmly in place and the cardboard tubing may be broken out leaving the coil in a skeleton form. The losses in such a coil are quite low and it is about as efficient as it can be made. The tickler or feed-back coils were wound on two-inch cardboard tubing on celluloid strips using No. 26 d.c.c. wire but with no spacing between turns. A rather thick solution of acetone and celluloid was used to coat the entire coil and after drying, the cardboard tubing was removed. It was found desirable not to use any tubing as a form for these coils since they were to be fastened by thread in the center of the tuning coils. The tickler coils were tied to the tuning coil celluloid strips at four points, making a skeleton form of tuning unit which should have quite low losses. To diminish the losses further, the coil unit is mounted



RADIO BROADCAST Photograph

FIG. 4

A view from behind the panel of the Jones receiver. The position of the inductance, the location of the condensers and the choke coil are noteworthy

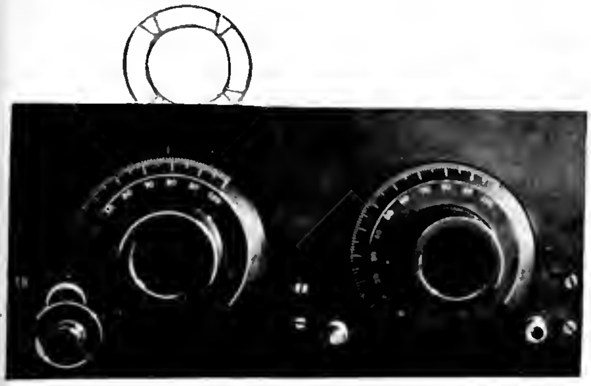


FIG. 5

How Mr. Jones's receiver looks from the front. Simple, as all short-wave receivers are, it has but two dials, only one of which needs to be a vernier, and a switch and jack. The inductance coil is also visible

RADIO BROADCAST Photograph

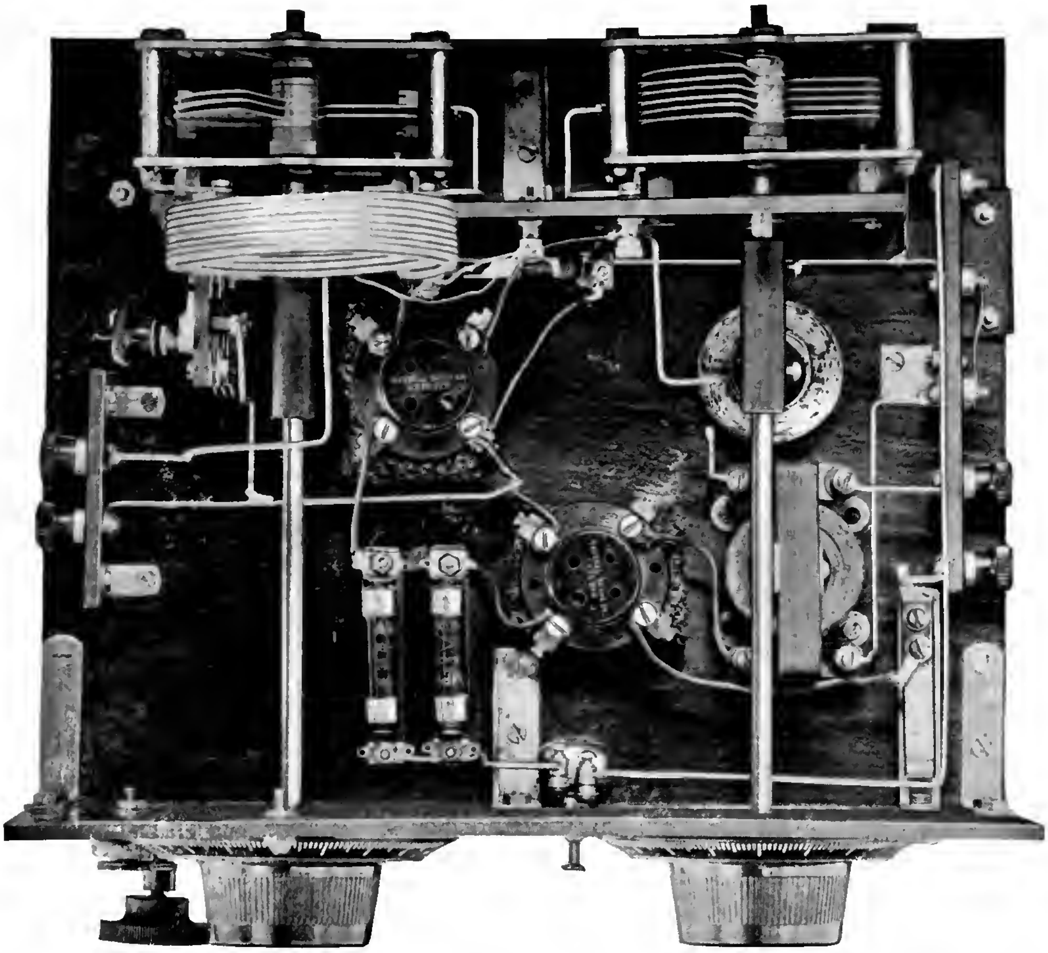
Tuning Coil L2 No. of turns	Tickler Coil L, No. of turns	Wavelength range, meters	Kilocycle range
4	5	17–30 (approx.)	17,640–9994
8	7	29–55	10,340–5451
13	9	41–92	7303–3259
24	11	75–130	2998–2306
43	13	80–170 (approx.)	3748–1764

up in the air above the rest of the apparatus and supported by the three heavy leads from the coil L2 which slip into binding posts up at the top of the rear hard-rubber panel.

The set of coils made up by the writer tuned over the wavelengths given in the table when using the secondary condenser in this set.

The adjustment of the balancing condenser C3 will change the secondary coil L2 calibration, so after it is once adjusted, it should be left alone. The method of adjustment used was to disconnect the antenna and counterpoise from coil L3 and tune it by means of the shunt condenser to some wavelength within the range of the receiver. Unless the balancing condenser is properly set, the receiver will not oscillate over the whole tuning range so that C3 can be easily adjusted down to a hairsbreadth until the receiver will oscillate properly.

To test the other tuning coils to see if they were exactly center tapped, other sizes of coils should be used for the coil L3 and the whole set worked on until the balancing condenser can be left in one position for all of the interchangeable coils. Then adjust the antenna circuit including L3 to a frequency just above the lowest which will be used such as 1482 kc. (201 meters) and the set is completed and ready for operation.



RADIO BROADCAST Photograph

FIG. 6

Looking down on the Jones receiver. This view gives a good idea of how the condensers are insulated from the dials in front of the panel. This method eliminates all danger of hand capacity. One stage of audio is included, although one additional stage can well be used, since the noise level on short waves is quite low

Additional Notes on the "R.B. Lab" Circuit

Experiences of Readers With an Extremely Interesting Circuit Described in Radio Broadcast for June—How to Run Leads Properly—Voltage Gain in the Amplifier—Use of Solenoid Coils

By KEITH HENNEY

Director, Radio Broadcast Laboratory

A CIRCUIT was presented in June RADIO BROADCAST that had been in use in the Laboratory for some months. It was called the R. B. Lab. circuit. A request was made of those readers who experimented with it to write of their difficulties or successes. This circuit was published for the first time in this country by Dr. L. M. Hull and was one of several which have come from the Radio Frequency Laboratories.

This circuit is shown again in Fig. 1. It will be seen that it differs from other amplifiers only in the transformer connecting the amplifier to the regenerative detector. In the original circuit built up in the Laboratory, toroid coils were used because of the exceptionally high gain of the amplifier. This characteristic made it necessary to either shield the amplifier or to use other means of eliminating unwanted couplings.

There is no reason, however, why ordinary coils, whether solenoid, diamond-weave, or whatnot, cannot be used in this circuit, provided the proper precautions are taken. The great difficulty constructors have with this circuit—as with all other high-gain amplifiers—is in neutralization and a few kinks will be described here that may be of aid. They will also apply to other radio-frequency amplifiers so that some of this information ought to be useful for all those home constructors who build good amplifiers for use ahead of their detectors.

In Fig. 1, the important leads are numbered. Now, in any amplifier, the tendency to oscillate varies directly as the capacity between the grid and plate and the wires attached to them, to the coupling between the grid and plate coils, and to the inductance in the plate circuit. In other words, no tube will oscillate unless there is coupling of some sort between the output and input circuit, and if there is no inductance in the plate circuit. If there are few turns in the plate, the thing will not oscillate—nor will there be much gain at the lower frequencies. With the ratios of coils given in the June article, the tube will oscillate if not properly neutralized, and it will oscillate then unless great care is taken to prevent magnetic feedback between coils. For this reason, toroid coils were chosen. Solenoids of small diameter can be used, but they must be separated by several inches, must be at right angles to each other, and there must be no metallic material between the coils. This latter point is important.

There is another important point. No matter how much capacity exists between grid and plate, it can be neutralized. It is only a matter of using a larger neutralizing condenser. In other words there is no particular harm in letting wires 1 and 3 be fairly close together. Since wires 1 and 2 are attached to opposite plates of a condenser there is no harm in letting them be fairly long or close together since the only result will be to increase the condenser capacity. The same may be said of wires 2 and 3, 3 and 4, and 3 and 5.

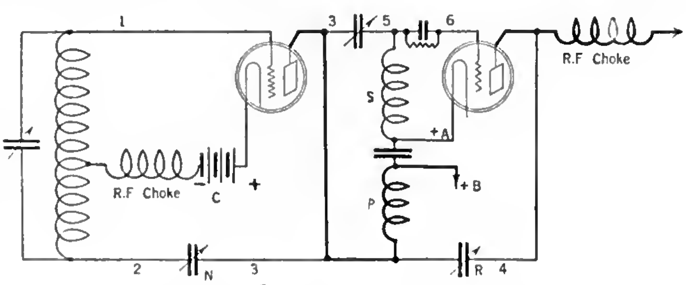


FIG. 1

The important wires in this circuit are numbered and in the text is outlined the wires which must be kept away from each other. The experimental circuit was described in RADIO BROADCAST for June, 1926, pages 121-5

ABOUT RUNNING THE LEADS

BUT between any other pair of wires there are phase differences which cannot be compensated by condensers—that is, these differences make it impossible to neutralize the amplifier. Especially important and obnoxious is the lead connecting the detector grid to the leak-condenser. The best way to avoid trouble here, is to make the tube socket terminal connect directly to the grid condenser-leak. Wire 6 is the cause of much trouble. It needs watching.

If the above precautions are taken, the tube can be neutralized at all broadcast frequencies, it will give considerable gain, and will not radiate into the antenna.

The radio-frequency choke in the amplifier mid-tap is important. The Samson choke is the only commercial choke that has been used. It is entirely satisfactory. One may be made at home by winding about 400 turns of small wire—No. 30—in slots carved into a bakelite rod about one-half inch in diameter.

If this choke is not included, the amplifier will oscillate at the natural frequency of the upper half of the input coil and the capacities attached to it. Another method of stopping this parasitic oscillation is to attach a small condenser from filament to the bottom of the coil as shown in Figs. 2, and 3.

Some readers have confused this circuit with the RADIO BROADCAST Universal described in RADIO BROADCAST for January and February and the L-C circuit described in *Radio*. In the June article the difference was pointed out. The circuit differs from the Universal in only one main respect—the plate coil has been reversed The L-C adheres to the original circuit published in *QST*. The *Radio* circuit has the peculiar feature that it is neutralized only at the point of resonance between the amplifier and the detector. Signals come with a shriek and a whiz—but once in they stay there.

Mr. R. P. Courtis of Detroit has played with the two circuits and has the following to say:

> I was very much interested in the article in June RADIO BROADCAST regarding the "Series Resonant" transformer of Doctor Hull.
>
> I have been doing considerable work on this type of transformer during the past year and I am very enthusiastic as to the possibility of developing an exceptionally efficient set from it.
>
> There are some points mentioned by Doctor Hull in connection with this circuit which do not appear in your article. One of them is the fact that the plate and grid coils do not need to have mutual inductance. It is perfectly possible completely to shield both of them and still have the circuit operate. Another point is the fact that the compensation by the neutralizing condenser is independent of the frequency when the transformer is tuned to resonance. The "locking-in" effect described in the article is due, as Doctor Hull points out, to the fact that compensation is not perfect for frequencies off the resonant point. The effect is very marked with low resistance coils, the set going out of oscillation with a shriek and click which is quite characteristic. It is a very interesting experience to tune one of these sets and have the broadcasting come in clear at the end of a violent howl.

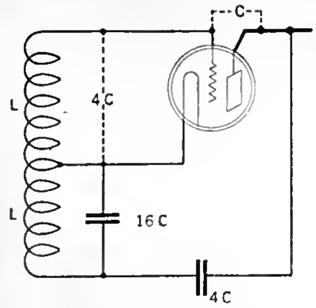


FIG. 2

A method of avoiding parasitic oscillations in the "Lab" circuit radio-frequency amplifier. It includes the addition of a small condenser from the mid-tap to the lower part of the coil. This makes a bridge whose arms are properly balanced

In connection with the separation of the primary and secondary, it would seem from this that it should be possible to use separate toroidal coils for these two inductors, thus allowing their use to best effect.

I would suggest, if you have not already tried them, that you insert a radio-frequency choke coil in the B-battery lead of the primary, and that you also try a transformer with the turn ratio of 3.16, with the primary and secondary in inductive relation but separated by about three inches. These coils may be wound on opposite ends of the same tubing for convenience in mounting.

The question of coupling between the two parts of the coupling transformer brought up by Mr. Courtis is interesting but does not seem to be of great importance. As a matter of fact, one of the reasons for our interest, originally, in the circuit was because the primary and secondary could be isolated from each other and thereby do away with any capacity coupling that ordinarily exists berween the two windings of a transformer. In the Browning-Drake circuit, an effort has been made to reduce the capacity coupling which should introduce an out-of-phase voltage and reduce the energy transfer.

VOLTAGE GAIN IN THE AMPLIFIER

THE curves in Fig. 4 will be interesting. They show the voltage gain from three methods of connecting a primary and secondary coil. Curve 1 is the ordinary transformer coupling, curve 2 the auto-transformer as used in the Universal, and curve 3 as used in the "Lab" circuit. There was no coupling between primary and secondary in this case. The coil constants were as follows: Primary inductance 60 microhenries. Secondary inductance 160 microhenries. Mutual inductance 25 microhenries. Secondary Resistance at 500 meters—16 ohms.

Using two poor coils—resistance about 30 ohms at 500 meters—The gain was about unity so that with a tube whose amplification constant was 8, there would be a voltage gain of eight, due to the coil and tube. As a matter of fact, it is simpler to use coils with mutual inductance between them since any coil tapped in the right place can be used.

Difficulty from hand capacity in the antenna circuit can be remedied by the scheme indicated in Fig. 5. Here is a balanced rotor condenser, or two condensers may be ganged and the proper side grounded. This puts part of the condenser at ground potential.

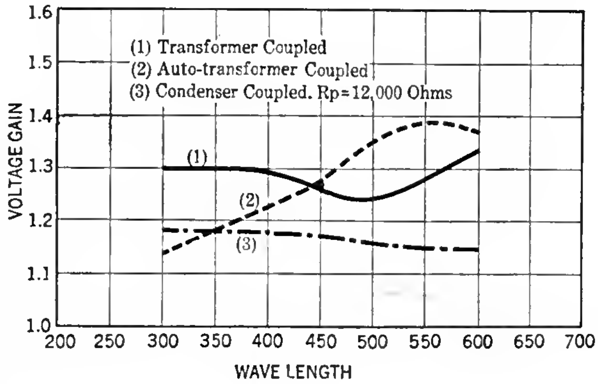


FIG. 4

The voltage gain of the interstage transformer of the "Lab" circuit, compared with two other types of coupling. The flat curve is important since it tends toward stability and evenness of regeneration and gain. Curve 3 is made on the coupling arrangement in the "Lab" circuit

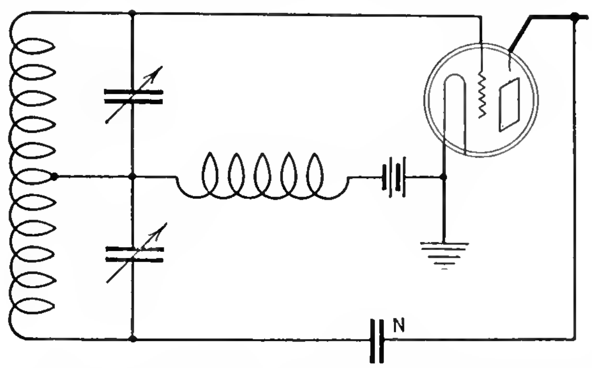


FIG. 5

A method of avoiding hand capacity in the radio-frequency amplifier. Two similar condensers with one side grounded are used. This necessitates that the condensers be alike and that the coil be tapped in the center

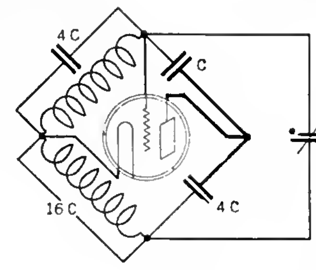


FIG. 3

The equivalent bridge circuit of that shown in Fig. 2

EXPERIENCE OF ANOTHER READER

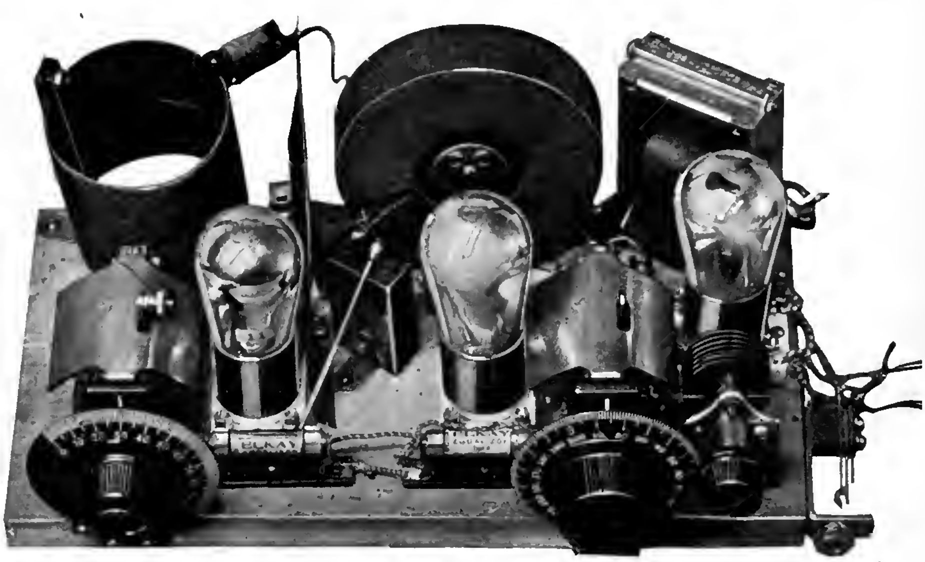
AN interesting letter about the "Lab" circuit has come from Mr. E. H. Brewer of Belmond, Iowa, who writes as follows:

We are about 300 miles from Chicago and it takes a very good set to bring in any of these stations in the day time but I get KYW any time on the speaker, when the static is not too strong.

I have not used the best of parts, and the coils are all home made, using .0005 condensers. Am using a toroid of 145 turns, cutting off 48 turns for primary, but found I got better results using a solenoid space wound on air, sec. 50 turns, primary 12 turns, these on a 3-inch form in the r. f. end.

Have not had any trouble in getting perfect neutralizing so have not had to use the tuned trap you speak of. The tone is all that one could wish with volume to equal any 5 or 6 tube: am using a 2-1 a. f. transformer in first stage with a $3\frac{1}{2}$ to 1 in the last.

My opinion is you have the best four-tube circuit ever published for the public.



RADIO BROADCAST Photograph

FIG. 6

An especially compact experimental model of the "Lab" circuit which was built up to determine proper wiring and placing of parts. Complete constructional data on several receivers of this type will appear in an early number of RADIO BROADCAST

The Listeners' Point of View

Conducted by ..... John Wallace

The Curious Jargon of the Broadcasting Industry

WITH every new industry, superstition, or pastime, there is introduced into the language a host of new words necessitated by the late discovery. The airplane introduced enough of new words to fill a tidy little volume. Psychoanalasis forced its pet word "complex" into common use. Radio, on its technical side, has introduced a bewildering number of hybrid Afro-Graeco-Franco-Whato words. These we are not concerned with here, but only with the new expressions that have arisen in connection with broadcasting itself There are only a handful of such new words, but they vary from the very choice to the utterly reprehensible.

When, in the earliest days of broadcasting, the necessity arose for some word to describe a new operation, it was naturally enough borrowed from the older profession of nautical "wireless." These terms, which found origin on shipboard, had a fine savour of the salt. Unfortunately for radio's vocabulary, they have fallen by the wayside and only two of them survive: Sign off, and Stand by. We admire these terms for the respectable air of age they lend to an industry that is so tragically new. May they endure and prosper!

The search for the proper word to describe the act of disseminating into the ether music, speeches, gun shots, and bad jokes, would seem to be still in progress; though the term broadcasting has a firm foothold. That horrible variation "broadcasted" which was introduced by some illiterate a while ago and enjoyed a lusty vogue, has now, happily, disappeared. The erroneous form once appeared in all the dignity of type in the first draft of the White Bill, H. R.5589, and was thus given an official stamp of approval it nowise deserved. However in the revised radio Bill, H. R. 9108, the committee changed the word to "broadcast" which ought to settle that point for good.

[*Editor's Note:* for the past three years, RADIO BROADCAST has used only the form, "broadcast"]

Some time ago an effort was made to substitute the ugly coined word "radiocast" for "broadcast." The poor excuse was that "broadcast" conveyed the wrong shade of meaning. Dr. Frank H. Vizetelly, lexicographer and managing editor of the *New Standard Dictionary* put this subterfuge on the kibosh in the following words:

> Perhaps I am to be permitted a word of comment upon the so-called "discovery" that the word "broadcast" as a verb means "to sow with seed or material substances." No careful student of language could possibly have introduced such a definition, for the word "broadcast" has been applied to pneumatology for more than 100 years. In other words, the term has been employed to cover both the concrete and the abstract. More than 100 years ago the Church was talking of "the doctrine of missionary zeal" having been "broadcast over Christendom," and "broadcast accusations" have been common to civilization almost since the dawn of politics.
>
> To my mind "radiocasting" is an ambiguous term, for it does not connote "diffusion," and as I understand it, that is what the radio stations do. It seems to me that such a term as "radiospread" or some word that conveys the sense of diffusion more clearly than "casting" might be used. We shall probably live to see the time when, just as we "phone" and "wire," we shall "radio," and the people, will understand what is meant without the necessity of our adding any suffix to convey the sense of dissemination which we know means "the act of disseminating, scattering or spreading abroad, originally seed, but now doctrines," etc.

But still the cacophonous "radiocast" lingers on in some benighted quarters. WJZ, which prides itself on its polite language, once said "radiated" which seems to us equally offensive.

The best term in present use is that employed by WOC. The expression "WOC transmitting" is simple, dignified, euphonious and quite adequately descriptive.

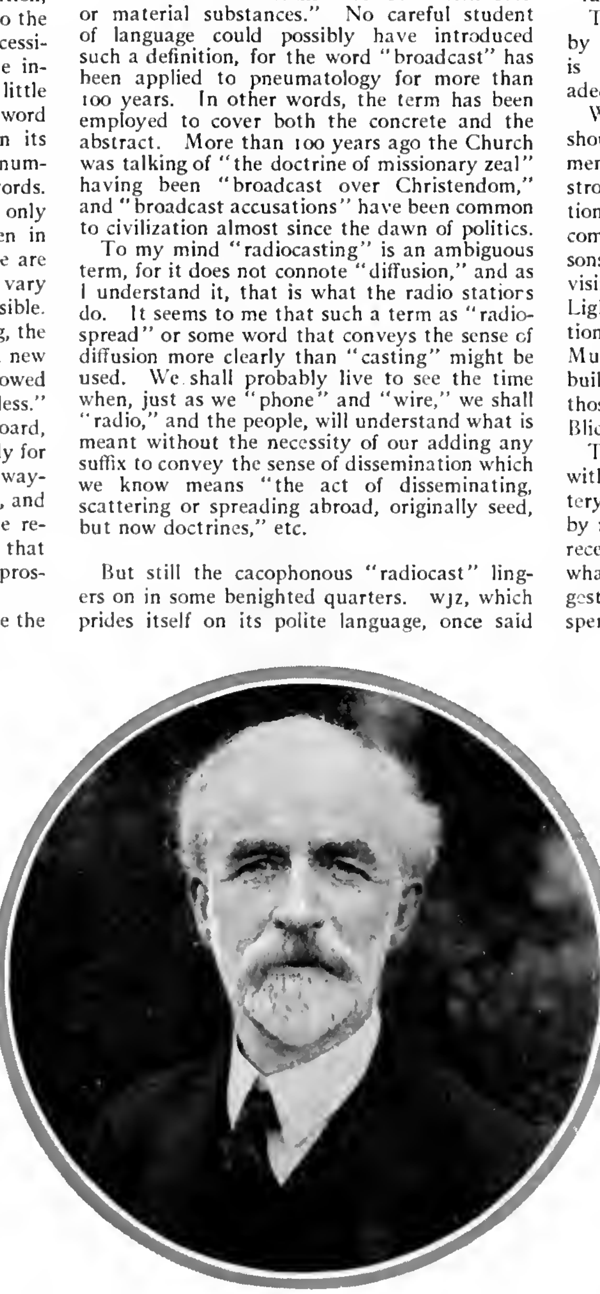
Word coining is at best a nefarious practice and should be prohibited by constitutional amendment. It has resulted always in hideous monstrosities. Witness the unpronounceable collection of letters—Realtor. Word coining has become a national obsession. Great hosts of persons devote the greater part of their lives to devising new adjectives to describe Sparry's Lightning Auto Spoke Kleanser or new appelations to dignify the job of the Rubber of Lame Muscles. The glorified janitors of Chicago's tall buildings have been seeking new titles, and among those proposed were a couple of wows, viz. Blidgadors, and Skyscrapadors.

This mania has entered into the field of radio with dire results. WLW described a serial mystery play as a "radario"! The question of libel by radio, which came up for the first time only recently, stirred discussion in New York over what name to call the new air menace. Suggested names were etheric turpitude, radiosperse, aero-slam and eth-bel!

But the worst crime was committed by KOA. After spouting a lot of tommyrot about how they were going to broadcast an all night program to all the principal continents on the globe, they said "when the General Electric company unleashes the vibrations of KOA and the silent ripples of ether sweep across oceans and international borders, the world will have experienced for the first time, the 'orb-raying' of a radio program." The word "orb-ray," it seems, was the glorious result of a much touted contest entered into by some ten thousand listeners for the purpose of devising a word with the same meaning in broadcasting circles that "circumnavigate" conveys to mariners. Ada C. Sessions, of Colorado Springs, coiner of the prize-winning word, received an especially designed ring, set with precious stones, as her reward.

When Ada Sessions comes to realize the heinousness of her deed we hope she eats that ring and chokes. Runners-up for the prize (which KOA believes "may be accepted a synonyms") include: "unicast," "georad," "audiate," "radiogrid," and "telearth."

The radio announcer has as part of his stock in trade a myriad of rubber-stamp phrases. One of the most com-



PROFESSOR EDMUND S. MEANY

Of the University of Washington, an authority on the early history of the Puget Sound Country, who has broadcast interesting talks on pioneer days through KFOA mon of them: "You have been listening to station xxx." This phrase ought to be scrapped, and for two reasons: first, it is verbose; and secondly, if the listener happens to have just tuned-in, it is untrue.

Clipping the foregoing down to "This is radio station xxx" leaves it still in a wordy condition. For obviously, if the listener has received this signal via a radio receiving set he is enabled to assume that it is a "radio station" he is hearing. "This is xxx" is quite enough.

"Olga Bedstein-Storry will now sing for you Suchandsuch" is another one of our pet abominations. Why the "for you"? Of course she is going to sing it "for us." If her intention was to sing it solely for herself she wouldn't have come to a radio studio.

"This program is presented through the courtesy of the Izaak Blotz Toothpick Company" involves a poor choice of words. Mr. Blotz is supplying the program not as a grandiloquent gesture of "courtesy" but as a cold and hard business proposition.

But if we seem to take offense at some of radio's pet phrases—and there are many more equally odious ones—do not think we see good in none of them. For among the expressions that radio has brought into being there is one we revel in and gloat over. And that is: By remote control.

Broadcasting by remote control! Ah, there is a toothsome morsel! How slitheringly it slides over the tongue! And if its pronunciation is delightful, its connotation is more so. The words suggest majesty, power, omnipotence. We haven't any clear idea as to just what the mystic phrase means—which only makes it all the more intriguing.

The Ipana Troubadours

As WE have before stated in this department, it is our belief that the best that radio has to offer is to be found in the regular weekly programs of the various indirect advertisers. Among such programs we think those of the Ipana Troubadours demand a high rating. The impression gained while listening to them is "here is a program that is prepared and is not merely happening." Studio programs too frequently convey to us the impression that we are listening-in on a rehearsal. The Troubadours play with a spirit and a precision which, if we are any judge, indicates careful and frequent rehearsal.

When the manufacturers sponsoring this program decided to go on the air they sought one Sam Lanin to direct their radio entertainment. Lanin had had six years as leader of a popular Broadway dance orchestra and a great deal of experience as a recording artist. He agreed to undertake the organization and leadership of the Ipana Troubadours providing he was permitted to get his own artists, and to pick them from the country's best dance and symphony orchestras.

That he did get the artists he wanted is now known to many thousands of radio listeners throughout the country. Lucien Schmit, for example, virtuoso 'cellist, was Walter Damrosch's first 'cellist for five seasons and he is also an accomplished pianist and saxophone player. Schmit is representative of the group.

The Ipana Troubadours broadcast their first program on April 8, 1925, from stations WEAF and WOO. They continued on these two stations until September 16 when they extended their broadcasting to six other stations. Since then, from time to time, other stations have been added until now these artists may be heard each Wednesday from the following chain stations: WEAF, WEEI, WGR, WOO, WCAP, WWJ, WLIB, WSAI, WOC, KSD, and WCCO.

That the Ipana Troubadours are popular there is no doubt. It is reported that from April 8, 1925, to December 31, 1925, most of the time using only two stations, they received more than 30,000 letters and cards of praise, suggestions, requests for special numbers and so on. After March of this year the correspondence department of WEAF, which has jurisdiction over the analysis of the thousands of letters received from WEAF's fans, concluded its study of the mail received during that month and gave highest honors to the Ipana Troubadours. The Vikings, and Blanch Elizabeth Wade, the G. R. Kinney Co. story teller, practically ran neck and neck for second place, but were more than a thousand letters below the total reached by the Ipana Troubadours. Other regular WEAF features which stood high in the list for the month were, respectively, The Gold Dust Twins, The Atwater Kent Radio Hour, Shinola Merrymakers, Silvertown Cord Orchestra, the Clicquot Eskimos and the Eveready Hour in the order named.

The Publicity-Seeking Listener

IF WE recollect our kindergarten days correctly, there was in effect, in that now distant class room, an efficacious custom designed to curb our infant urgings to play leap-frog in the aisles, gedunk small girls' pig tails in the ink wells or conceal white mice in the teacher's desk; and likewise intended to reward our juvenile zeal in the manufacture of paper chains, pen wipers, and sundry other useful articles.

The system was a simple one. All the little boys and girls who had been good little boys and girls during the week were privileged to see their names emblazoned in glittering white chalk on the blackboard of a Friday.

And the value set upon this distinction was inconceivably enormous. An equivalent delight could have been secured by no less than six lollypops, with perhaps a top and a fish hook thrown in. To see our own name, our very own, blooming there on the blackboard in great big Palmer Method characters! And even more delightful was the ensuing bit of ritual. Teacher grandly and impressively approached the blackboard, and designating each successive name with her long pointing stick, read each and every one of them aloud. Aloud! The joy of hearing one's own name read out—and out loud at that!

But now in these our later years, it unpleasantly occurs to us that we were being duped all along! We begin to gravely suspect that the six lollypops might have possessed slightly more in-

THE IPANA TROUBADOURS

Heard through WEAF and about a dozen stations regularly each Wednesday night. The lower illustration shows the mail received by this organization during their first season of broadcasting. Correspondents need have no fear that their letters are not carefully examined, for at WEAF, for instance, a special department devotes itself to nothing else. The upper illustration shows the Ipana musical organization, led by Sam Lanin trinsic value, or perhaps even the lowly fish hook. Perhaps old age has embittered us, perhaps we have been too ruthless in sloughing off our first illusions, but be that as it may, we have come to the final, irrevocable, and perhaps cynical conclusion that there is no immense value attached to having one's name read aloud.

But our sad business of listening to the radio has forced upon us the further conclusion that advancing age has not effected in all our fellow beings the same disillusionment. We find an alarming number of persons—adults if you were to go by the size of their shoes—who continued to revel orgiastically in the sensuous delight of hearing their names made known to the world at large.

This number is dedicated to Mrs. Sarah B. Guelph of Safron, Ohio" and "This one is by special request of John and Minnie Henshaw of 4337½ Sunnyside avenue" and "We have here a nice little telegram: "Your program coming in fine, Joe Blotz, Pillsburg, Texas."

Arff! It hardens our arteries and makes us foam at the mouth. But listen! We'll let you in on a secret. We have discovered a way to still our wrath. We just utter into the loud speaker in a hissing voice: "Morons! Morons!" For we have decided that since our maximum delight at hearing our name read aloud was experienced at the age of six, all other persons who continue to enjoy this proceeding way into their adult life are still mentally about six years old.

Well, we don't intend to attempt to change human nature, even such decadent manifestations of it; but at least we can enjoin the radio station managers, who presumably aren't all morons themselves, to stop encouraging this infantile practice. If each and every station would simply refuse to read out names, even at the cost of a few listeners' vanity, there would soon be no names to read—and everybody would be happy, particularly ourself.

The stupidity of reading telegrams for the edification of any one other than the sender is painfully evident. No telegram we ever heard contained an intelligent remark and all could be boiled down to the "program coming in fine" formula.

Likewise glaringly apparent is the absurdity of formally dedicating a ditty that takes about one minute to sing and is probably poorly sung at that. Such practice evinces a sadly distorted sense of proportion. It is like making out a last will and testament, gorgeously embossed on thick crisp parchment, and decorated with multitudinous signatures, seals, attests and red ribbons, for the purpose of bequeathing three cents to cousin Charlie.

If the singer who squawks a piece has a right to dedicate his or her operation why not extend the privilege? On the sheet music, alongside the composer's quite legitimate dedication line, let's have a dedication by the printer who set up the type, and another by the binder, and perhaps one by the paper maker, with a publisher's dedication thrown in. And how about the office boy who keeps the publisher's office neatly swept extending his felicitations "To My Father" or "To M. K. H" on the copy?

CARRIE PRESTON RITTMEISTER

Who broadcasts a daily shopping service—an advertising feature—through KNX at Hollywood

Nor can we see much sense in dragging in some listener's name by the "by request" device. It is a fact worthy of note that the pieces played "by request" are generally the most worn out and hackneyed numbers in the whole of radio's repertoire. We wish that some of our more homicidically inclined fellow listeners would make careful note when "The Prisoner's Song" or "Mother Machree" is ordered by Mr. Blank of 27 East First Street, Daytona, Alaska, and immediately despatch to the given address an infernal machine of sizeable proportions. Of course we do not rail against the listeners' communicating with the stations and requesting particular selections, and we further think that the stations should comply by playing them if they are not too hackneyed. But it is so tremendously asinine for the announcer to predicate the piece with a long story about who it is for. There is no excuse for the practice; if the assumption is that the listener who wrote in must be advised that this is his request number the assumption is silly. For if he asked for a particular piece it is only reasonable to presume that he will recognize it when it comes on. Or if, on the other hand, the assumption is that the announcement will summon the listener to his receiving set, it is slightly more silly, for, if he is not at his set, his set is probably turned off, in which case the announcement would not come through very loudly anyway.

In short, there's not a reason in the world for ever announcing a listener's name from a radio station except to please that listener himself. And if he is so much of an idiot as to be pleased by hearing his name broadcast we would rather see him not pleased—in fact we would rather see him shot.

Several of the best stations have, for quite a while, enforced more or less definite rules against such publicizing. A few make a half hearted effort to cut it down to a minimum. But the vast majority do it to death.

Just recently three Mid-Western stations have turned their attention to this matter with varying results. WOAW managed to put on its third anniversary program (O gala day!) with a drastic reduction in the number of names disseminated. But this worthy move was not to last. On the question of the continuance of the policy the management of WOAW had these silly remarks to make:

The institution of an absolute non-dedication program depends largely on the attitude of the artists, and we are going to allow them to settle the matter. Dedications have become numerous in the last year or two. Complaints have increased proportionately. There are many times when acknowledgment of communications becomes necessary, such as during elections, storms, world's series and other occasions. This also applies to the award of prizes on radio programs. We believe a gradual solution is preferable to any hasty conclusion. The leading stations, both in the East and West, as well as in the Middle West, are still acknowledging communications and offering prize programs, and in view of the fact that these are often beneficial to the listeners, we have not adopted any definite restriction, although acknowledgment of communications and prize programs do not take place as often as in the past.

The manager of WSAI without mincing matters at all, made announcement that he "did not want listeners to send telegrams in order that they might hear their names mentioned over the air."

KMOX at St. Louis made the following caviling compromise:

It is the policy of station KMOX not to interrupt programs by the reading or acknowledgment of telegrams, but realizing that radio listeners who send telegrams desire them acknowledged by radio, KMOX has adopted the policy of acknowledging all telegrams received before 5:00 P. M. at 5:00 P. M. each day. All telegrams received after 5:00 P. M. are acknowledged at 11:00 P. M. each evening. Under this plan, those who desire to hear acknowledgment of their telegrams may tune-in at a specified time and be sure to hear the acknowledgment.

MUSICIANS HEARD BY HALF THE COUNTRY

Willem Von Hoogstraten, left, and Edwin Franko Goldman. Mr. Von Hoogstraten, is conductor of the New York Philharmonic Orchestra, which broadcasts on Wednesday and Saturday nights through WJZ and associated stations. The Goldman Band, led by Edwin Franko Goldman is heard through WEAF and associated stations several times per week. Both organizations are foremost of their type

Against Sentimental Ballads

As we sit here writing, Mr. Jeremiah Sullivan, of WQJ Chi-KA-go fame, is drooling into our left ear, via the loud speaker, a silky stream of sentimental ballads.

We do not object overstrenously to Mr. Sullivan as an announcer. But as a singer we like him not. He is one of that terrible Two-Voiced Tenor type. One voice for the low notes; a sign and a pause, and then—another voice for the high notes; the latter bearing not the slightest sort of resemblance to the first.

The effect is very disconcerting: as though two different individuals were coöperating, with only a fair degree of synchronization, on the singing of the same solo. An effect which, as far as getting across properly, is about as successful as crossing a river in two jumps.

Moreover as we sit here pounding these long-suffering typewriter keys the temperature is hovering around ninety in the shade. It is high noon and the sun is beating down abundantly. Nothing daunted, Mr. S. continues to sing saccharinely about couples wandering in the moonlight and watching the rest of the world go by. In about two seconds we shall gracefully exterminate him by that simple method known as tuning-out. For the present we shall revel in the torture. For next to occasionally being pleased by our radio there is nothing we enjoy more than getting thoroughly mad at it. If we can't have the one extreme, give us, we beg, the other. And singing sentimental ballads at noon of a hot Saturday is certainly the last extremity of something or other.

As the perspiration trickles down our nose we find ourself somehow unable to sympathize with the swain who "would climb a thousand mountains just to hold your hand agayn-uh." In fact we are inclined to consider him an idiot and to wonder why he doesn't forget "the sweetest little girl-uh who's waiting for me-uh" and sit him down somewhere in the shade with a fan and a cool pop bottle.

It has been said there is a time for everything. If this is true there is probably some appropriate time for the singing of sentimental ballads. We suggest that it is at three o'clock in the morning. For if any hardy listener has succeeded in keeping himself up until that late hour he is probably in a ripe mood for such like crooning. If he has kept himself up with the aid of the juice of the juniper he may even chime in himself!

For, in truth, sentimental ballads were never meant to be listened to. Their pleasure lies in the performing. They are meant to be sung by isolated—and preferably slightly deaf—groups of males, in automobiles, in shower rooms, at Kiwanis club luncheons, at Class of '03 reunions, in the wee small hours, and in spiritus frumenti.

Click! Exit Mr. Sullivan.

Broadcast Miscellany

THE American Society of Authors, Composers and Publishers, according to WJZ, is limiting the broadcasting of certain tunes to keep them from being "killed" by too frequent radio repetition. Many selections from some eight musical shows now playing in New York are protected by a radio restriction of one performance a week.

WITH the increase in the number and quality of paid and courtesy broadcast programs, the so-called "chain hook-ups" are becoming more popular and extensive. There are to-day seven radio circuits, or chains of stations, which broadcast certain features simultaneously. No longer is the famous Bell System chain the sole circuit to offer entertainment of this calibre to several communities at one time.

The competition began when the Radio Corporation, General Electric and Westinghouse companies began to tie up their stations through the use of telegraph wires. To-day it is possible to connect, not only WJZ, New York; WRC, Washington, and WGY, Schenectady, but also WBZ, Springfield; KDKA, Pittsburgh; KFKX, Hastings, KOA, Denver; KGO, Oakland; KYW, Chicago, and WCAD at Canton, New York, which make a chain almost as extensive as the WEAF, WCAP *et al.* circuit, and literally a longer cross-country hook up.

In the Pacific Northwest, stations KGW, at Portland; KFOA, Seattle and KHQ, Spokane, have combined for the mutual exchange of good programs. KFI, at Los Angeles, and KPO at San Francisco are also understood to swap their best features by interconnection.

Some of the New England stations have also connected their transmitters on occasions; WEAN, Providence; WNAC, Boston, and WLWL, New York, all now controlled by the Sheppard Company, are hooked up for special features. WIP, Philadelphia; WGBS, New York, and WGP, Atlantic City, tie up so that they can carry a single program when found desirable.

Another scheme for the handling of indirect advertising features is sponsored by Norman Baker, owner of KTNT, who suggests that the smaller stations combine to transmit simultaneously on the same wavelengths, but without interconnection. That is, each station would carry similar programs independently, but on the same wave, to avoid utilizing so many channels for the same program.

CHARLES E. ERBSTEIN, who was the guiding spirit of WTAS, is back on the air again together with his Personality and his familiar "heh-heh," which should give delight to "Willie, Tommy, Annie, Sammy," and others of his one time vast audience.

He is offering a series of programs over WLIB on Tuesday nights from 9 until 1 o'clock. As formerly, he presents Fred Hamm's orchestra—The Boss's Own—in special jazz numbers, and occasionally the band accompanies Mr. Erbstein's readings of "The Bowlegged Boy," "The Cremation of Dan McGrew," "That Old Sweetheart of Mine," and "The Curse of Drink.'

NEXT to this peerless potage of program piffle there is no department of radio reviewing we more enjoy reading then Quin Ryan's "Inside the Loud Speaker" column in the Chicago *Sunday Tribune.* It fairly teems with ideas. This from a recent issue:

> All the radio stations should lay off the air for two weeks—the same two weeks—while the performers take their vacations. Listeners need vacations, too. On the other hand, the radio stations might start broadcasting vacations, so that the listener could stay right at home and enjoy himself without leaving the city. You could hear the jolly sound of people splashing in the water, the swish of the canoe, paddle, the whir of the fishing reel.
>
> Deer hunting might be broadcast from the northwoods—bang! bang!—or the puffing of the fat man climbing mountains, or the hectic mutterings of another gent as he slices a fast one into the tall grass.
>
> A summer vacation on the radio, with all the feel and sound of a jolly recreation, minus the troubles and tribulations of the usual summer trip—served right in your home free of charge.

WE LISTENED to the broadcast of a track meet for the first time last Saturday—that of the National Collegiate Athletic Association. And our verdict is: not so good. Like basketball and hockey, track is ill adapted to broadcasting. True, a track meet is a magnificent spectacle, but one which it is quite impossible to depict in words. Unlike football, track is quite devoid of the element of the "unexpected." Of course we do not mean that the man whom you expected to win may not come in last. But there are no sudden and dramatic reversals such as occur in a football game. The most "newsy" thing that could happen would be for a man to break his leg on a hurdle or for a new world record to be set. Neither of these events occur with any degree of frequency.

The announcer—we forget what station it was—did his durndest to put some excitement into the thing but succeeded only in being stage-talky and uninspiring. Thusly:

> And now as a bee-u-ti-ful fleecy cloud half obscures the sun and casts a fleeting shadow on the colorful throng that crowds the grand stand, the runners take their marks. They're off! My, my, how those boys can run! Just watch those boys run! My, my! Listen to that crowd shout! Can you hear that crowd shout? Just listen to that crowd shout! . . .

Unfortunately the race, which was a hundred yard dash, occupied only about ten seconds. As you may judge by timing yourself on the above quotation, the announcer came in a bad sixth.

FOR the first time in the history of broadcasting, a series of exclusive radio talks has been published in book form and offered to the radio public. This book is titled "The Universe of Stars" and is made up of 22 chapters, each chapter comprising the manuscript of a radio talk in the Harvard Observatory series broadcast through the Boston station, WEEI.

AT THE STUDIO OF KFH, WICHITA, KANSAS

A rehearsal of Flowtow's opera, "Martha," one of the recent feature broadcasts from this station. Left to Right: Roy Campbell, tenor; Sybil Johnson, soprano; J. L. Fox, announcer; Sue Fulton, contralto, and Lester Weatherwax, baritone

The Importance of Acoustics in Broadcasting

Distortion in Receiving and Transmitting Apparatus—A Little Discussed Form of Distortion—The Importance of Correct Microphone Placement in Studios

By BENJAMIN F. MIESSNER

IF A piano dealer sold you a perfectly toned piano, to all intents and purposes exactly similar to the one used in the studio of your favorite broadcasting station, moved it into your home, and if when playing it gave the tinkly imperfect notes which you are accustomed to hear from a loud speaker when listening to a pianoforte recital being broadcast, you would certainly not be satisfied with your deal! Yet, look at the exaggerated statements which constantly appear in radio advertisements—statements backed up by superlative adjectives descriptive of the *perfect* reproduction obtainable with such and such a set or loud speaker.

Broadcasting and receiving apparatus, taken as a whole, is an *acoustical* instrument, and this fundamental fact must be fully realized if it is ever to attain a high state of development. The value of such a system depends chiefly on the accuracy attained in the reproduced sounds as compared directly with the originals. Absolute perfection is not necessary, of course, for pleasure to be derived from its use. It is obvious, nevertheless, that the higher the quality and more natural the reproduction, the more valuable the system becomes. Poor quality should not be tolerated but highest quality must always be the goal of the engineer. By the acoustician's expression "quality" is meant the degree of perfection or degree of naturalness attained in reproduction. There is a definite difference between the quality of a musical number, the quality of the sounds comprising it, and the quality of their reproduction. The first is obviously an aesthetic attribute defining the musical worth of the composition; the second refers to the timbre or tone color of the sounds comprising the music; and the third describes the degree of perfection attained in duplication or reproduction of those tones at the receiving end.

There are many sources of distortion in every modern radio system. The input sound must undergo numerous conversions from one type of vibration to another; there is a chain of these steps in the transmitter and a similar one, reversed in sequence, at the receiver. Each converting device, such as the microphone, audio-transformer, vacuum tube, loud speaker, etc., adds its share of characteristic distortion. Some distortions are opposite to others so that neutralization occurs to some extent. Others are the same in type and exaggeration results. These distortions may be likened to a series of translations from one language to another of an original piece of literature. If one of Shakespeare's works, say *Romeo and Juliet*, was translated from the original English into Chinese, then from Chinese into Russian, then from Russian into German, and then backward through the same series, each translation being made by a different translator and none familiar with the subject matter, the final re-translation into English would, no doubt, only remotely resemble the original.

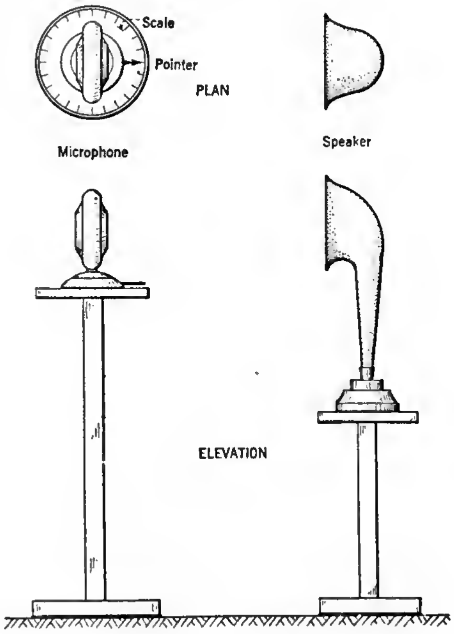


FIG. 1

The arrangement of emitter (loud speaker) and receiver (microphone) for measuring directional characteristics of a sound receiver, is here shown. If the characteristics of the emitter were desired, the scale and pointer would be transferred to it from the microphone

Or, if you see an object itself and its reflected image, side by side, these so arranged that the image is the final one of a number of reflections from a number of imperfect mirrors, a striking visual analogy is presented. Imagine some of the mirrors to be concave and others convex planes, others doubly curved, some of colored glass, and others very dirty in places, and you can imagine for yourself how nearly like the original object will be its last reflection; and yet this is similar to the process of the radio system.

Most of us fail to realize the great degree of distortion in radio because we have unconsciously grown so accustomed to the even worse performance of the telephone and phonograph, and because our sound memory is inaccurate in many ways. If we listen to the reproduction of sounds that we are familiar with, our subconscious self tries to fit what we hear to what we have heard before, and the imagination, if we repress our critical impulses, supplies the deficiencies, providing they are not too great.

In this way we accept substitutes in audition as we do with moving pictures in vision. By long experience and habit, we can forget the lack of stereoscopic effect, of color, and sound, and other omissions which are present in real life yet are absent from the screen. But our ability to do this does not lessen the desirability of completing the picture by supplying the missing parts.

Acoustically, the most familiar sources of distortion in broadcasting and receiving apparatus may be grouped in two general classes:

1. Those due to an overall frequency characteristic of the system which is not flat. That is, the ratio of reproduced intensity to original intensity of sounds is not the same for all frequencies.
2. Those due to an overall amplitude characteristic of the system which is not rectilinear. That is, the ratio of reproduced intensity to original intensity of all sounds is not the same for all intensities. Assuming both flat frequency and rectilinear amplitude characteristics, there may be distortion due to the loss of certain sounds because of insufficient sensitivity. This will result in the omission of weak tones; or there may be distortions due to the introduction of extraneous sounds, caused for example, by carbon hiss in microphones, commutator ripple in transmitter plate-current generator, tube noises, static, interference, etc. All of these have received and are now receiving considerable attention from radio engineers, and will therefore not be discussed further at this time.

A NEW KIND OF DISTORTION

THERE is, however, another and very serious type of distortion in radio systems, which, so far as the writer has observed, has not been discussed and is not being investigated. This new type of distortion is caused by the directional characteristics of microphones and loud speakers. We are all familiar with the megaphone, which is used to increase the voice intensity in some particular direction. Surely most of us have also noted that loud speakers give strongest sounds at a given distance when one listens directly in front of them. We have perhaps also listened through megaphones to a distant source of sound and noticed that the sounds were loudest when the megaphone was pointed towards that source. We see, therefore, that sound receivers and emitters do have directional characteristics, and most of us are aware of that fact in a general way. The exact nature of these directional effects, however, is not generally known or understood, and it was because of this fact that an investigation was undertaken, and its results herein reported.

The writer first observed and made use of these directional effects at the Naval Aviation Station, Pensacola, Florida, in 1916, during the development of anti-noise microphones for aircraft for the United States Navy. From 1918 to 1922, he investigated them further, and applied the knowledge so gained in electro-phonographic research for one of the large phonograph companies. Further studies on the subject were made in 1924–5.

It has been found that practically all sound receivers and emitters, including horns, diaphragms, etc., have directional characteristics. Sound emitters project sound best in some directions, and sound receivers receive sound best from some directions. Moreover, the directional characteristics vary with the frequency of the sound, so that sounds of equal intensity and at the same angle to the receiver or emitter, but differing in pitch, are received or emitted in differing intensities. Complex sounds from any musical instrument, due to the wide variation in frequency of their component fundamental and harmonic elementary tones, are changed in quality because the intensity ratios of these component tones are altered. The distinctive quality of any sound source is determined by the number and relative intensities of its overtones and fundamental. If any of these component partial tones are omitted or changed in intensity, the tone timbre or quality is altered. The complex tones of violins and clarinets sometimes degenerate into the simpler tones of the flute because the high partials that determine the difference between them are suppressed in the radio system (transmitter and receiver). The flute, in certain registers, is almost a simple tone; the violin and clarinet tones on the other hand, contain many high harmonic components. If these are suppressed by the inability of the microphone to respond to them, the characteristic timbre is lost, and the remaining simple tone is indistinguishable from that of the flute or from that of an organ pipe which, in effect, it is. The important matter in regard to microphones and loud speakers is to determine whether the directional characteristic is constant or variable with frequency. If it is constant, only the loudness of the sound will be changed with varying direction; if variable, the loudness, and in addition, the timbre, or quality of the sounds will be changed, which is a much more serious matter.

STUDIO DIRECTORS SHOULD UNDERSTAND MICROPHONE DIRECTIVITY

THE directional effects of microphones, therefore, become of great interest to the studio director. For example, the mere positions of the various instruments in an orchestra may completely spoil the quality of the reproduction. The tone balance of the various instruments must be determined not merely by their relative intensities and distances from the microphone, but by their angles to it. Furthermore, some types of instruments, regardless of volume or distance, reproduce with changed timbre unless faced by the microphone. Others may be at a great angle to the face without much change. For some types of microphones, sounds approaching the sides or back are only moderately reduced in volume. In others, the back is as sensitive as the front, while the sides have practically no sensitivity.

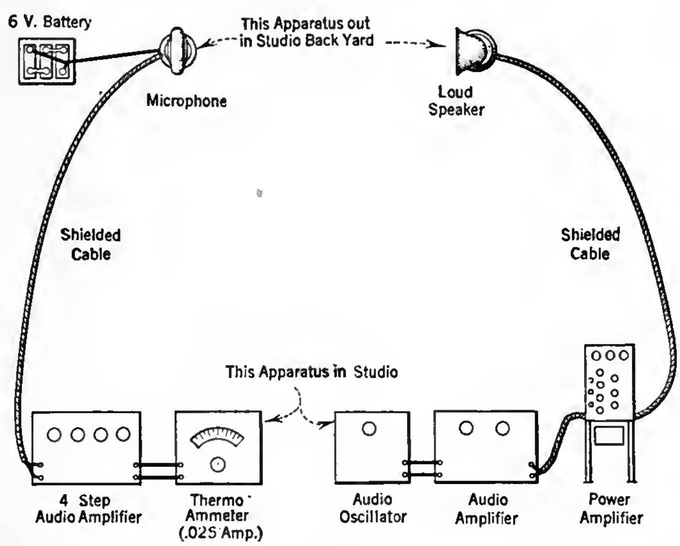


FIG. 2

In this diagram is shown the general arrangement of the entire apparatus for directional characteristic measurements. Very careful precautions are necessary to shield the receiving and transmitting apparatus to prevent direct transfer of electrical energy between these two units

The accompanying curves show the directional characteristics of several types of microphones and loud speakers for various sound frequencies. The measurements were made out of doors far enough from reflecting bodies, such as buildings and ground, to prevent errors due to interfering reflected waves. A vacuum-tube audio oscillator of variable frequency, feeding into a loud speaker, provided the sound source. The frequency was determined by tuning with a piano as a known frequency reference standard. The microphone was mounted so that it could be turned horizontally about a vertical axis through the instrument. A pointer and angularly divided scale indicated the angle between a line joining the speaker and microphone, and the horizontal axis through the face of the horn or microphone. The microphone in either case was connected to a resistance-coupled audio amplifier operating through a step-down transformer into a thermo-milliammeter. For each frequency, the amplification was adjusted for full scale meter deflection with the microphone facing the loud speaker. The microphone was then turned through successive angles and the meter read for each angle. For each curve, the frequency, sound emission intensity, and the distance, were invariable, only the angle of incidence on the microphone being varied. The audio-amplifier was tested for non-linear amplitude distortion by subjecting it to a voltage input of the same frequency range and intensity impressed on it in the microphone tests. It was found to be linear within the range of amplitudes used in these tests. Inasmuch as the frequency was constant in any given test, the frequency characteristic of the emitter and receiver could not influence the results.

One factor of importance, however, was beyond our control, so that the measured data are somewhat disturbed by it. I refer to the impurity of the impressed sounds. At all frequencies, the emission contained, beside the fundamental frequency noted, numerous overtones, the presence of which cloud to some extent, although not greatly, the accuracy of the measured results. Nevertheless, the nature, if not the precise degree of the effects under study, is determined, and it is certain that pure sound sources will accentuate the characteristics herein shown. Fig. 1 is a sketch showing the physical arrangement of the apparatus in these tests, and Fig. 2 is a diagram of the connections.

TEST CONDITIONS AND PROCEDURE

THE distance between the loud speaker and the microphone was six feet during the tests. Great care was exercised in supporting both, so that no reflecting surfaces of appreciable size were near either microphone or loud speaker. The operator who set the microphone angle for each measurement was required to be at least ten feet away during the actual measurement. At two or three feet, the presence of his body so altered the sound field about the microphone as to cause large errors in the measurement.

The test procedure was as follows:

1. Set up emitter and receiver facing each other as shown in Fig. 1.

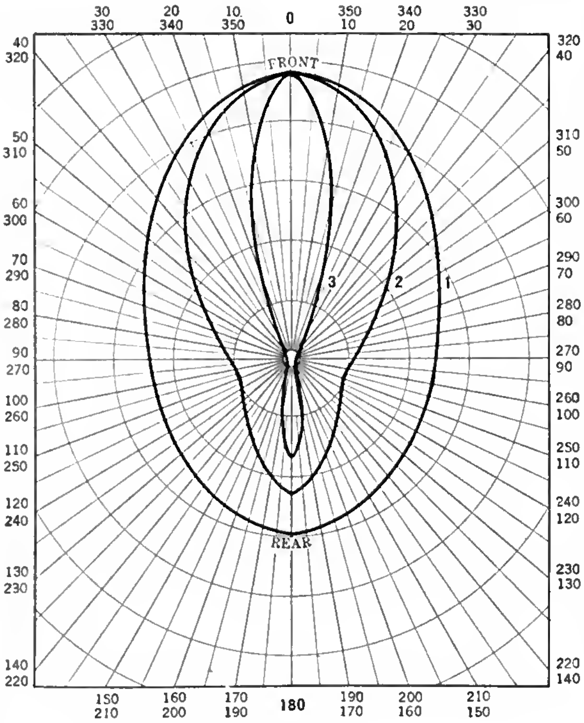


FIG. 3
This group of polar curves shows the directional characteristics of horns and also of flat diaphragms enclosed on one side, as shown in Class 1, Fig. 4, for frequencies of (1) 100 cycles; (2) 1000 cycles, and (3) 5000 cycles

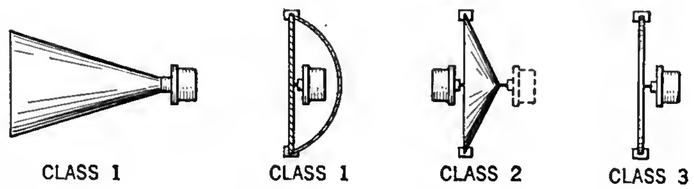


FIG. 4
The three general types of electro-acoustic devices used to convert sound into electric currents, or vice versa, the directional characteristics of which have been carefully studied

2. Adjust test tone frequency to desired value.
3. Adjust intensity of test tone so that the thermo-ammeter measuring the received tone gives full scale deflection.
4. Turn emitter or receiver (depending upon which characteristics it is desired to determine) through successive 10-degree angles and read meter for each angle.
5. Repeat 2, 3, and 4 for each tone frequency desired, as for example, 100, 1000, and 5000 cycles.

While many different microphones and loud speakers have been investigated in this manner, they may all be reduced to three general classes so far as directional characteristics are concerned, as suggested by the results of these investigations. These three classes are as follows:

1. Horns; diaphragms with one side closed.
2. Conical diaphragms open on both sides.
3. Flat diaphragms open on both sides.

These three types are shown schematically in Fig. 4. It may here be remarked that the directional characteristics of any given type are reversible, *i.e.*, they are the same for emission and reception.

In the first class are included all types of single horns as used on loud speakers or in phonographs; also flat diaphragms, as used in the usual studio microphones where sound waves have access only to one of its sides, are included in this class.

In the second class are the open cone speakers such, especially, as the Crosley, Pathé, and others, having both sides of the cone fully exposed, and some cones having the back partially open, such as the Western Electric, Farrand-Godley, and similar types.

In the third class are flat diaphragms or double cones vibrating together and fully exposed on both sides, such as the reproducers of C. Messick and the Acme Apparatus Company.

Fig. 3 shows three curves for a loud speaker horn of ordinary type, typical of Class 1. In Fig. 5 are shown three curves for an open cone speaker typical of Class 2. Fig. 6 shows three curves for a flat diaphragm typical of Class 3. In each of these figures the three curves correspond to frequencies of 100, 1000, and 5000 cycles.

ANALYSIS OF CURVES

THE general features of the curves in Fig. 3 are:

1. A gradual falling off in intensity from front to back at low frequencies, and a tendency toward definite minimums at about 90 to 120 degrees from the face with increasing frequency.
2. A definite tendency towards beam effect at higher frequencies.

The general features in Fig. 5 are:

1. A definite minimum at about 90 to 115 degrees.
2. Approximately equal front and rear intensities, and decreasing rear intensity with increasing frequency.
3. Definite tendency towards beam effect with increasing frequency.

The general features of Fig. 6 are:

1. Equal front and rear intensities.
2. Very sharp and low minimum at 90 degrees.
3. Definite tendency towards beam effect with increasing frequency.

So far as broadcasting microphones are concerned, those in wide use in this country have approximately the characteristics of Class 1, as shown in Fig. 3.

Strange as it may seem, these instruments are about half as sensitive on the back side as they are on the front, and the direction of minimum sensitivity lies a little towards the rear of the sides. This directional sensitivity shows the studio director that direction as well as distance plays an important part in the placing of his instruments.

A far more important point, however, is the changing of directional characteristic with frequency. It is plainly evident that if a musical instrument, say a cello with low pitched fundamental and high pitched overtones, be placed on an angle of 45 degrees to the face, as it well might in a studio, the fundamental would be received about 75 per cent. as loud as if it were in front of the microphone, while overtones of the order of 5000 cycles would be reduced to less than 10 per cent.

It will be noted that the variation in directional characteristics of the three types indicates a progressive change from Class 1 to Class 3, that is, Class 1 is most nearly unilateral; Class 2 shows strong signs of bilateral characteristics, and Class 3 is purely bilateral. It may be added that the horns and diaphragms whose character-

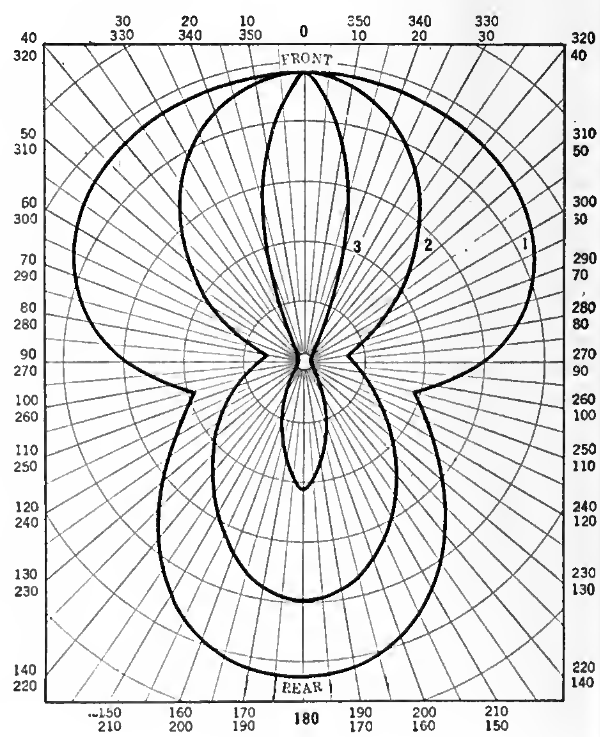


FIG. 5
In the group of polar curves shown above, we find the directional characteristics at (1) 100 cycles; (2) 1000, and (3) 5000 cycles, for open cone acoustic devices as shown in Class 2, Fig. 4

istics are here shown, all had a diameter of one foot.

AN OPTICAL ANALOGY

CEILING lights are often provided with reflecting or diffusing devices the function of which is to distribute the unequal illumination of the lamp uniformly about the room. If these devices acted like loud speakers in acoustics, the light of different frequencies or colors comprising the white illuminant emission would be unequally distributed. The longer wavelengths of red light would be spread over the room with about uniform intensity. The yellows and greens would show signs of concentrating over a narrow region, while the blues and violets would be confined almost entirely to a small area directly beneath the lamp. At every point in the room we would find some color region predominant, from violet, below the lamp, to red at the extreme sides. At no point in the room could the true white (assuming that the lamp emits white light) illumination be present. This optical analogy compares very closely with the action of sound projectors in acoustics. At no point about a loud speaker with a directional emission varying with frequency can the sound color or timbre of a complex sound have the true color found in the source of its sound, for example, the throat of the horn. This, no doubt, is one of the factors which make loud speaker reproduction inferior to head phone reproduction as all of the emission in the latter is confined directly to the ears of the listener, and this directional distortion cannot occur.

It is shown by these acoustical measurements that a serious form of distortion results from the directional characteristics of broadcasting microphones and receiving loud speakers, which has been absolutely unexpected by the radio engineer. The seriousness is even much greater than the curves indicate as the directional distortion of the microphone is again repeated by the loud speaker. This means that the overall directional distortions of the system as a whole, from microphone to loud speaker, may be represented by the square of the curve values shown.

The directional characteristics described herein apply, of course, to modern broadcasting microphones, such as the WE–373–W. Briefly, the reasons are as follows:

This microphone acoustically is of the type with exposed front and closed back. It is most sensitive to sounds approaching its front side and less for other directions, as shown in the curves for that type in Fig. 3. The reason it responds to sounds approaching its back is that these sounds diffract around the housing or back shield and reach the diaphragm in that way. The amount of this diffraction depends on the wavelength as compared to the size of the housing. If the housing be small compared to the wavelength, the tones will diffract around it very easily and with but little loss in intensity. If it be large in comparison, the diffraction will be suppressed and the diaphragm itself will be in a region of pronounced "shadow," or low intensity sound. This effect is well known for all types of wave motion, and applies to objects and apertures alike.

The fact that a microphone cannot be used as a loud speaker has no bearing on the subject. The diaphragm itself and the nature of its housing and near-by objects only determine these characteristics. The size of the diaphragm has some influence, inasmuch as, with a given frequency of sound, it determines the ratio of object to wavelength, which governs the degree of diffraction. However, its only effect is to shift the frequency region wherein directional distortion is greatest, that is, the curve shapes shown, instead of applying for frequencies of 100, 1000, and 5000, might apply to 500, 5000, and 25,000—or for the same frequencies, the curves will appear as shown in the accompanying Fig. 7.

The effects are clearly demonstrable with light and other forms of radiant wave energy—radio, for example. They are very clearly shown in the accompanying curves for sound.

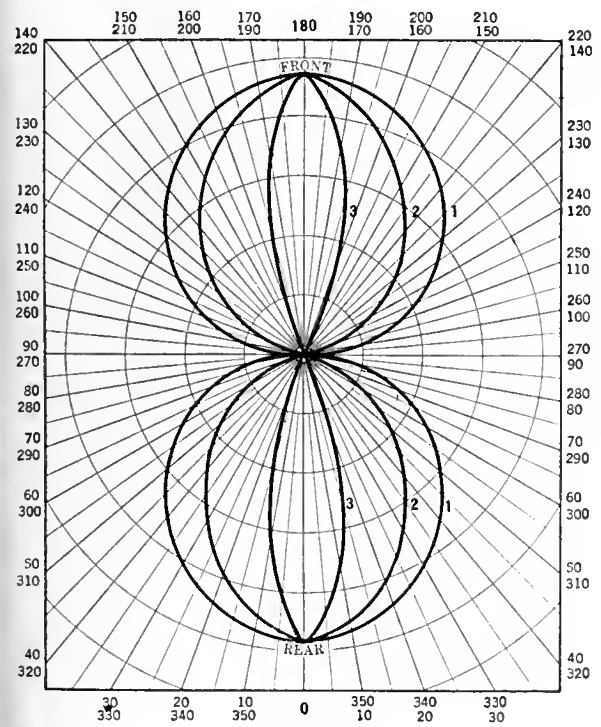


FIG. 6

The directional characteristics for flat, open diaphragms, of Class 3, Fig. 4. are here shown. The frequencies are the same as mentioned for the two previous diagrams

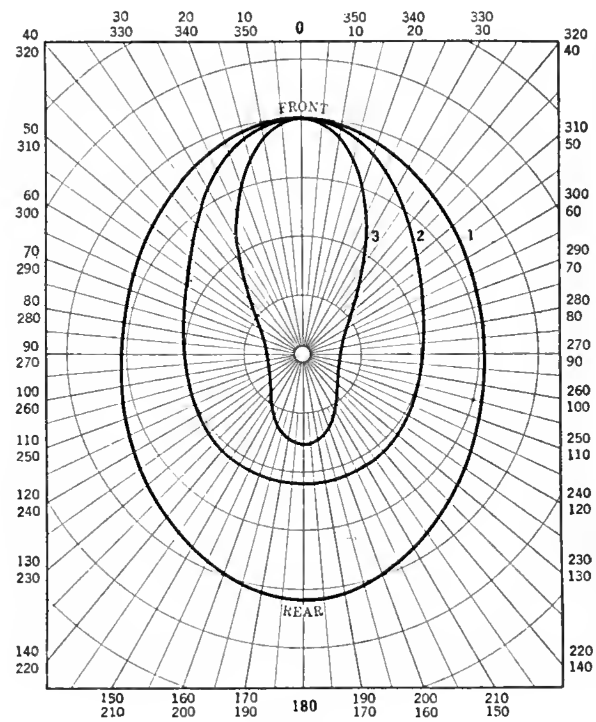
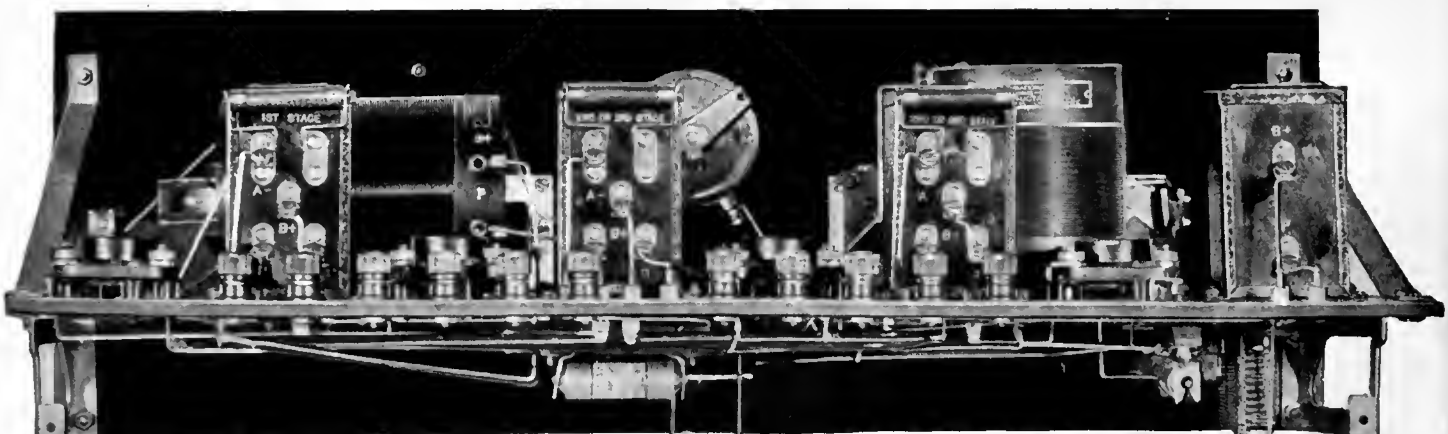


FIG. 7

The approximate directional characteristics for broadcasting microphones at the standard test frequencies. Variations from those of Fig. 3 are due to decreased size of these microphones



Radio Broadcast Photograph

ONE ASPECT OF THE R. B. IMPEDANCE-COUPLED BROWNING-DRAKE

A rear view of the receiver indicates the disposition of the various parts both above and below the sub-panel. Note how the central support bracket aids in preventing the sub-panel from sagging at its middle. This picture should be studied in conjunction with that on page 403

The R. B. Impedance-Coupled Browning-Drake

A New Model of An Ever-Increasingly Popular Standard Circuit Incorporating Latest Constructional Ideas · A Five-Tube Set With Impedance-Coupled Audio Amplification

By JOHN B. BRENNAN

Technical Editor, Radio Broadcast

IF A careful analysis of the outstanding receiver circuits of the past twelve months be made, it is not unlikely that of them all, there will be only a few that rate high in popular esteem by virtue of their excellence in performance. Of these few, not many were patterned after other than the old and familiar tuned radio frequency plus regenerative detector circuit.

In most cases, receivers are what they are because of the individual type of apparatus employed, providing that to start with a good circuit is selected.

The Browning Drake, not an exception to the rule, is one receiver that amply illustrates this principle. First described in Radio Broadcast for December, 1924, that circuit has stood the test of time remarkably well. The circuit itself is not revolutionary; just a simple tuned, neutralized, radio-frequency amplifier, with regenerative detector. To this may be added any type of audio amplifier that strikes the fancy of the constructor. It is the tuned part of the receiver that requires the main attention because, with a good audio amplifier, the signal in the plate circuit of the detector tube may be amplified to the desired power and then outputted to a satisfactory loud speaker. In speaking so of the audio amplifier, it is not the intent to belittle this very important section of a receiver; it is intended that emphasis be placed on that end of the receiver upon which we depend for the accomplishment of our tuning, for if that part of the receiver is not satisfactory, the best audio amplifier in creation will not help matters.

And so in the following description of a Browning-Drake receiver improved and refined down to the minute, especial attention is placed upon the tuning units with which the proper selection of stations is made.

Note that the coils employed are so fashioned as to incorporate all the main features of low loss design with which we usually associate fineness of tuning and excellent sensitivity. The condensers which tune the coils are of the conventional straight frequency-line type, so useful in tuning to the shorter wavelength stations. The particular coils employed in the model described here, are manufactured by the National Company of Cambridge. However, for those who wish to approximate this coil construction at home, suitable specifications enabling one to do so are presented elsewhere in this article.

In tuning the National coil-condenser combination, the operator will note an apparent broadness of tuning. This effect is produced by the peculiar shaped condensers which allow of a 270-degree rotation for a given capacity range. A change in capacity takes place at a correspondingly slower rate here than if other straight capacity-line condensers with semicircular rotor plates were employed.

The Browning-Drake Receiver Circuit

THE Browning-Drake circuit, now immensely popular, was first introduced by a national radio magazine when Glenn H. Browning's article on that circuit, designed by him and Fred Drake, appeared in the December, 1924, Radio Broadcast. *That circuit employed transformer-coupled amplification. One year later, in December, 1925, Mr. Browning described, in this magazine, another model of his circuit with impedance-coupled audio amplification. Great advances in constructional ideas have occurred since that time. This article, by John B. Brennan, completely describes a Browning-Drake receiver employing impedance-coupled amplification which has as neat a constructional appearance as is possible to find outside of the product of a factory. Every home-builder may easily duplicate this design himself. And when he is through, he will have a set that is noted for its sensitivity, high quality of reproduction, and, not unimportant, extremely neat appearance. Install the set in a handsome cabinet, and the two in a well appointed living room—what more in a radio set could one ask? This set was designed in the Laboratory of* Radio Broadcast *by Mr. Brennan with the able collaboration of Mr. Glenn H. Browning. For those constructors who prefer to build with large blue prints, a set of these can be secured from the Booklet Department of this magazine at $1.00 the set.*—The Editor.

PROPERLY CONTROLLING VOLUME

ONE problem in the design of a radio receiver has been to control volume effectively without affecting the quality of the output in the loud speaker. In cases where the volume control is incorporated in the audio amplifier channel of a receiver, some shifting of the audio frequency characteristics usually results when the control is varied. This change is one direct cause of imperfectness of quality.

Obviously, if the volume control is "moved" far enough forward of the audio channel, it then becomes possible to regulate volume without thereby causing mild forms of distortion in the all-important audio channel. Some constructors place this volume control in the detector circuit; others in the radio-frequency amplifier circuit. In the Browning-Drake model described here, the volume control, consisting of a variable 30-ohm resistance, is inserted in series with the filament ballast which regulates the flow of current to the radio-frequency tube filament. The advantages thus gained are two-fold. First, a very smooth control of volume is obtained without affecting the tone characteristics of the audio channel. Secondly, by placing the variable resistance in this position, overloading of the radio-frequency amplifier, especially on local station reception, is prevented. This control, at this point, enables the constructor to maintain a high degree of neutralization which in turn allows of fine tuning without the probability of self oscillation.

In the radio-frequency amplifier stage, it was observed that a type 199 tube neutralized more perfectly and consistently than a 201-A tube. Also, the actual gain for the 199 tube, taking into consideration the possibility of incomplete neutralization for the 201-A tube, was perhaps as much as with the latter, and is to be preferred in the final construction.

In the detector circuit, regeneration is obtained by the usual tickler method whereby a movable coil is coupled to the secondary circuit. A 201-A tube is employed in this circuit.

The Facts About This Receiver

Name of circuit	Browning-Drake.
Type of circuit	One stage tuned, neutralized, radio-frequency amplification, a regenerative detector, plus three stages of impedance-coupled audio-frequency amplification, including output device.
Number of tubes	Five. R. F. (199); Detector (201-A); Three A. F. (high-Mu in first and second stages, and semi power, such as the 112 or 171, in last stage).
Frequency Range	1500 kc. to 545 kc. (200-550 meters).
Volume Control	Series resistance in filament circuit of radio-frequency amplifier tube.

RADIO BROADCAST Photograph

THE COMPLETED RECEIVER

A front panel view of the R. B. Impedance-Coupled Browning-Drake receiver, showing some of the "insides," impresses one with the similarity between it and a neat manufactured set

For ease of assembly, the National Impedaformers were selected, although if it is so desired, any standard type of choke coil, condenser, and grid leak may be substituted. The National Impedaformers combine, in one unit, the choke coil, isolating condenser, and grid leak; by means of convenient terminal posts it is a simple job to wire these units into the circuit. Also, in the input unit, following the detector stage, a most serviceable radio-frequency choke coil is conveniently included within the housing. It is employed to insure against passing radio frequency currents into the audio-frequency channel.

The plate impedances L5, L6, L7 are one hundred henries each, and the grid leaks R5, R6, R7, are all 0.1 megohms. The isolating condensers C5, C6, and C7 are of 0.1 mfd. These values are given for those who prefer to buy their choke coils etc., separately.

IMPEDANCE COUPLING FOR AUDIO CHANNEL

THREE stages of this impedance-coupled audio-frequency amplification are employed. In the first and second stages, high-Mu tubes permit of a higher amplification than if ordinary 201-A tubes were used. In the last stage, a special output coil is included for the following reason: Where quality output is desired of an audio amplifier, it is out of the question to use other than the type 112, 171, or other tubes especially designed for power work. With such a tube in the last stage, better quality is obtained than if the 201-A type of tube were

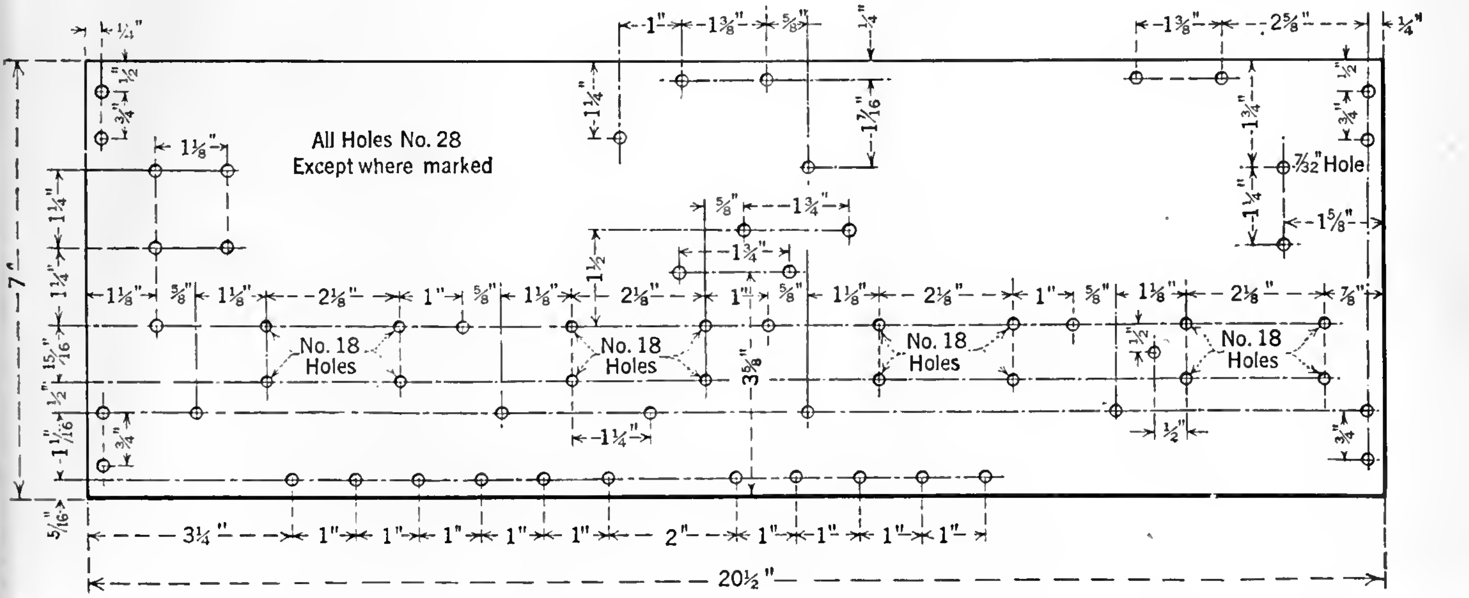


FIG. 1

The holes to be drilled in the sub-panel for mounting the various pieces of apparatus thereon are laid out in accordance with the specifications given above. It will be noted that, excepting for the antenna adjusting condenser hole and the holes for securing the Impedaformers, all the holes are drilled with a No. 28 drill. In addition to the holes indicated here, numerous small holes are conveniently located in the sub-panel to allow connecting wires to be fastened to their terminals. Lastite connectors may be utilized for this latter purpose to be used. Since with the power-output type of tube it is necessary to employ a high value of B battery voltage on the plate, it would be ruinous to do so without making some provision for the protection of the loud speaker windings. This is exactly what the output coil does. Instead of the drag that is exerted on the diaphragm of the loud speaker by the direct current when the output coil is not contained in the circuit, thereby tending partly to paralyze the diaphragm, the special output circuit places on the loud speaker an a. c. signal voltage, allowing the diaphragm to swing freely in synchronism with the signal impulses or discharges of the isolating condenser in this circuit.

THE CIRCUIT AND PARTS

IN REVIEW of the circuit, we find it consists of the following: A stage of tuned, neutralized, radio-frequency amplification, and a regenerative detector followed by three stages of impedance-coupled audio-frequency amplification, in the output of which is arranged a special isolating device as a protection for the loud speaker.

To construct a receiver similar to the model described here, the following parts should be obtained:

1 Micarta Panel 3/16" x 7" x 21"
1 Radion Sub Panel 3/16" x 7" x 20½"
1 National BD-1B Tuning Unit } or home-made coils as described
1 National B-D 2B " " }
2 National Illuminated Dials
5 Benjamin Universal Sockets
3 National Impedaformers
1 National Choke—100 henries
1 Precise 50-mmf. Tuning Condenser.
1 XL Neutralizing Condenser Model N.
1 Sangamo 0.00025-mfd. fixed condenser with grid leak clips

Radio Broadcast Photograph

FIT FOR A KING

The R. B. Impedance-Coupled Browning-Drake receiver all dressed up in a console cabinet, the product of the Detroit Woodcraft Company. The lower section contains the batteries, while the compartment above holds the receiver. A slot is sawed in the back of the cabinet, allowing the connections from the batteries to be made to the various binding posts arranged along the rear of the sub-panel

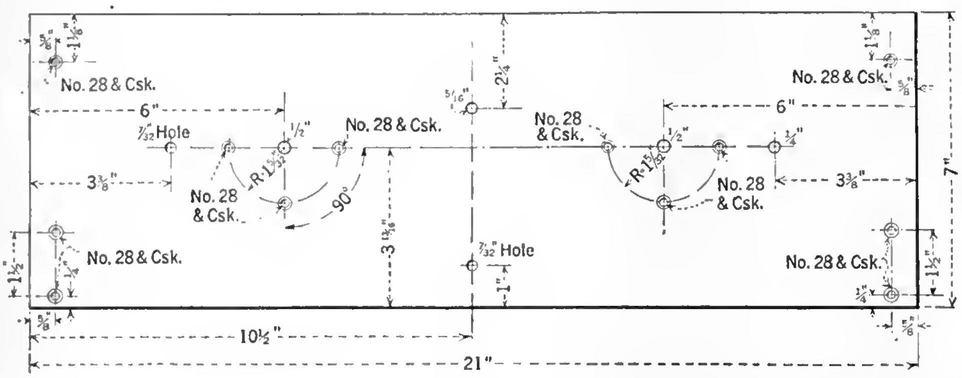


FIG. 2

All the dimensions necessary to lay out the main panel are given here. Care should be taken in accurately spotting and centerpunching the hole marks. In drilling, be sure not to tilt the drill—this would be sure to result in erroneous spacing of holes

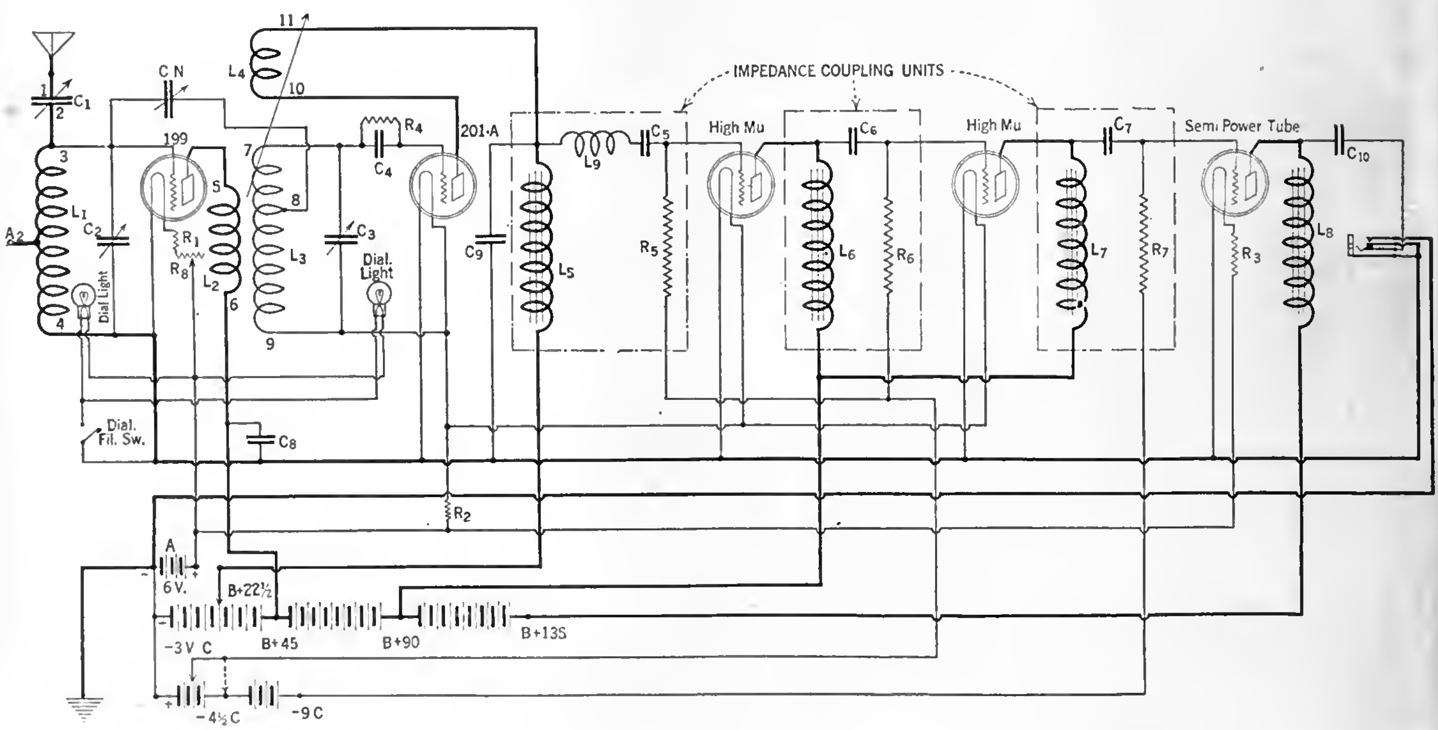


FIG. 3

This is the complete circuit diagram of the R. B. Impedance-Coupled Browning-Drake receiver. Note that in the radio-frequency amplifier, a 199 tube is employed while in the other sockets a 201-A is used for the detector, two high-Mu's for the first and second audio stage and a semi-power tube in the output stage. A choke coil, L8, and condenser, C 10, are employed to good advantage in isolating the direct current component of the B potential from the loud speaker windings. Only alternating current finds its way to the loud speaker. The values for the various parts indicated by letters are as follows: C1, 0.00005 mfd.; C2, 0.0005 mfd.; C3, 0.00025 mfd.; C4, 0.00025 mfd.; C5, C6, and C7, 0.1 mfd.; C8, 1.0 mfd.; C9, 0.005 mfd.; C10, 1.0 mfd.; CN, 0.00002 mfd. neutralizing condenser; L1, antenna coil; L2, plate coil; L3, detector secondary coil; L4, tickler coil; L5, L6, and L7, plate impedance coils, 100 henries each; L8, output impedance coil, 100 henries; L9, radio-frequency choke coil; R1, 50 ohms; R2, 1.33 ohms; R3, 0.5 ohms; R4, 5 megohms; R5, R6, and R7, 0.1 megohms; R8, 30 ohms

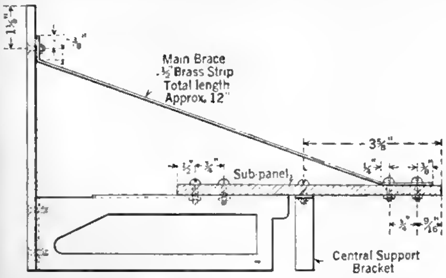
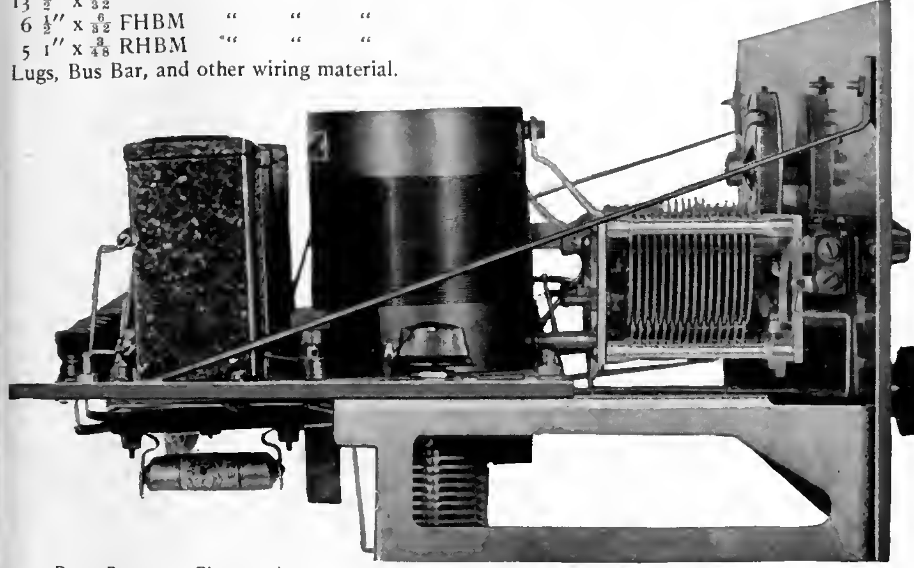


FIG. 4

Besides utilizing a standard sub-panel bracket such as that manufactured by Benjamin, two additional supports are employed to provide a substantial assembly. Due to the fact that the sub-panel is located so near the end of the Benjamin brackets, additional supports are necessary. The diagonal braces prevent the sub-panel from warping along its width, while the central support bracket insures against warping along its length

1 Electrad Grid Leak—5 megs
1 Sangamo 0.005-mfd. fixed condenser
2 Sangamo 1-mfd. fixed condensers
3 Brachstats with mountings, types 1D, 2B, and 3B
1 Carter Filament Switch
1 Carter Filament Control Output Jack
1 Centralab Rheostat—30 ohms
2 Benjamin Standard Brackets
12 Eby binding Posts
1 Brass Strip 31″ x ½″ x $\frac{1}{16}$″
10 1″ x $\frac{6}{32}$ RHBM Screws with Hex. nuts
16 ½″ x $\frac{8}{32}$ " " " "
13 ½″ x $\frac{6}{32}$ " " " "
6 ½″ x $\frac{6}{32}$ FHBM " " "
5 1″ x $\frac{8}{48}$ RHBM " " "
Lugs, Bus Bar, and other wiring material.



Radio Broadcast Photograph

READY TO BE PLACED IN A CABINET

This end view clearly illustrates the compact construction of the receiver. Fixed condensers, filament ballasts and antenna adjusting condenser are situated below the sub-panel, while above it are the tuning and audio amplifier units

For the sub-panel, undoubtedly it will be necessary to obtain a 21″ length and then with a hack saw remove a half inch strip from one end. After this has been done, the hole marks may be spotted on the sub-panel in accordance with the layout in Fig. 1. The use of a T-square will aid materially in marking off these holes correctly. From the lengthwise edge nearest, scribe a line with a sharp-pointed nail or pencil $\frac{5}{16}$″ in. Then another $1\frac{1}{16}$″ away from the last one and so on, until all the lengthwise dimensions are accounted for. After this has been done, the vertical dimensions are laid off, working from left to right. It will be noted that most of the holes are drilled with a No. 28 drill except where otherwise specified. At any rate, all the holes may first be drilled with a No. 28 drill and then enlarged to correct size where necessary.

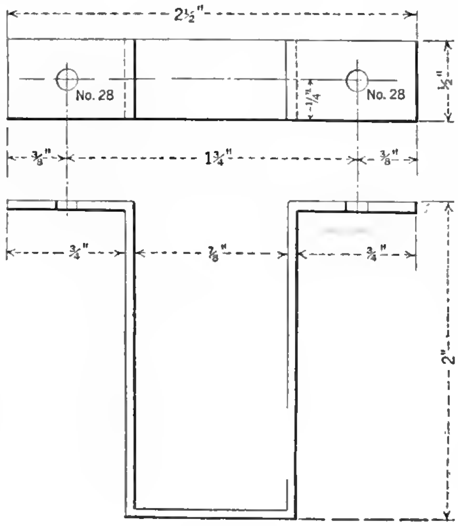


FIG 5

The central support bracket is fashioned from half-inch brass strip $\frac{1}{16}$″ thick, as indicated above. Roughly, six and one half inches of strip are required for the bracket

When all the holes have been drilled in the sub-panel, the main panel (Fig. 2), may be laid out in exactly the same manner as the sub-panel and then drilled.

ASSEMBLING THE PARTS

BEFORE passing on to the assembly of the apparatus upon the sub-panel and main panel, it will be well to prepare the bracket and braces which must be fashioned from ½″ brass strip as shown in Figs. 4 and 5. These strips serve to support the sub-panel and prevent sagging at the middle. Next, the tuning units, 30-ohm rheostat, filament switch, and output jack are mounted on the main panel. Before each piece is finally fastened, make sure that all bolts, nuts, etc. are tight.

Then, the three audio units and output coil are fastened to the sub-base with the ½″ x $\frac{8}{32}$ round head brass machine screws. In between these units are mounted four of the Benjamin sockets by means of the 1″ x $\frac{6}{32}$ round head brass machine screws. The fifth socket is mounted directly forward of the second and at the extreme front edge of the panel. At the rear are arranged eleven of the twelve binding posts.

The Benjamin brackets may now be fastened to the main panel with the ½″ x $\frac{6}{32}$ flat head brass screws, after which the sub-panel is mounted in place. The brass strip braces are then screwed into place. At the main panel ½″ x $\frac{6}{32}$ flat head screws are used for the purpose, while at the sub-base, round head screws are used.

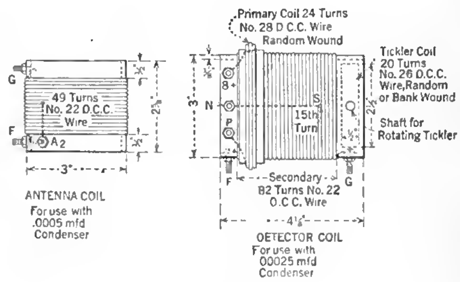


FIG. 6

When it is desired to construct coils for use with other condensers than those specified, the sketches here will prove of aid. Should coils of low loss characteristics be desired, the constructor may well follow the coil winding specifications outlined by Mr. Thatcher in the March, 1926, Radio Broadcast

Directly behind the second audio unit and third socket, on the under side of the sub-panel, is mounted the central support bracket, necessary to prevent sagging which would otherwise occur due to the weight of the material mounted above.

Looking over the top of the main panel from the front, two holes will be seen at the left of the antenna coil unit. In the larger of these two holes is mounted the 50-mmf.

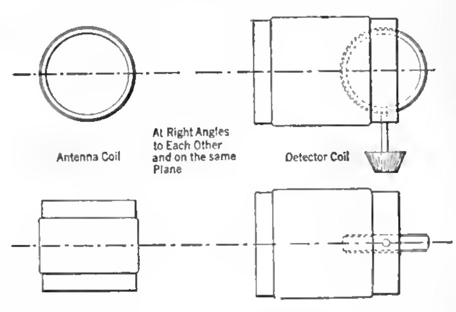


FIG. 7

When employing home-made coils, it is absolutely essential to the successful operation of the receiver that the coil units be at right angles to each other and mounted on the same plane. If this point is not observed, neutralization is practically impossible. The sketch here shows how the home-made coils should be mounted

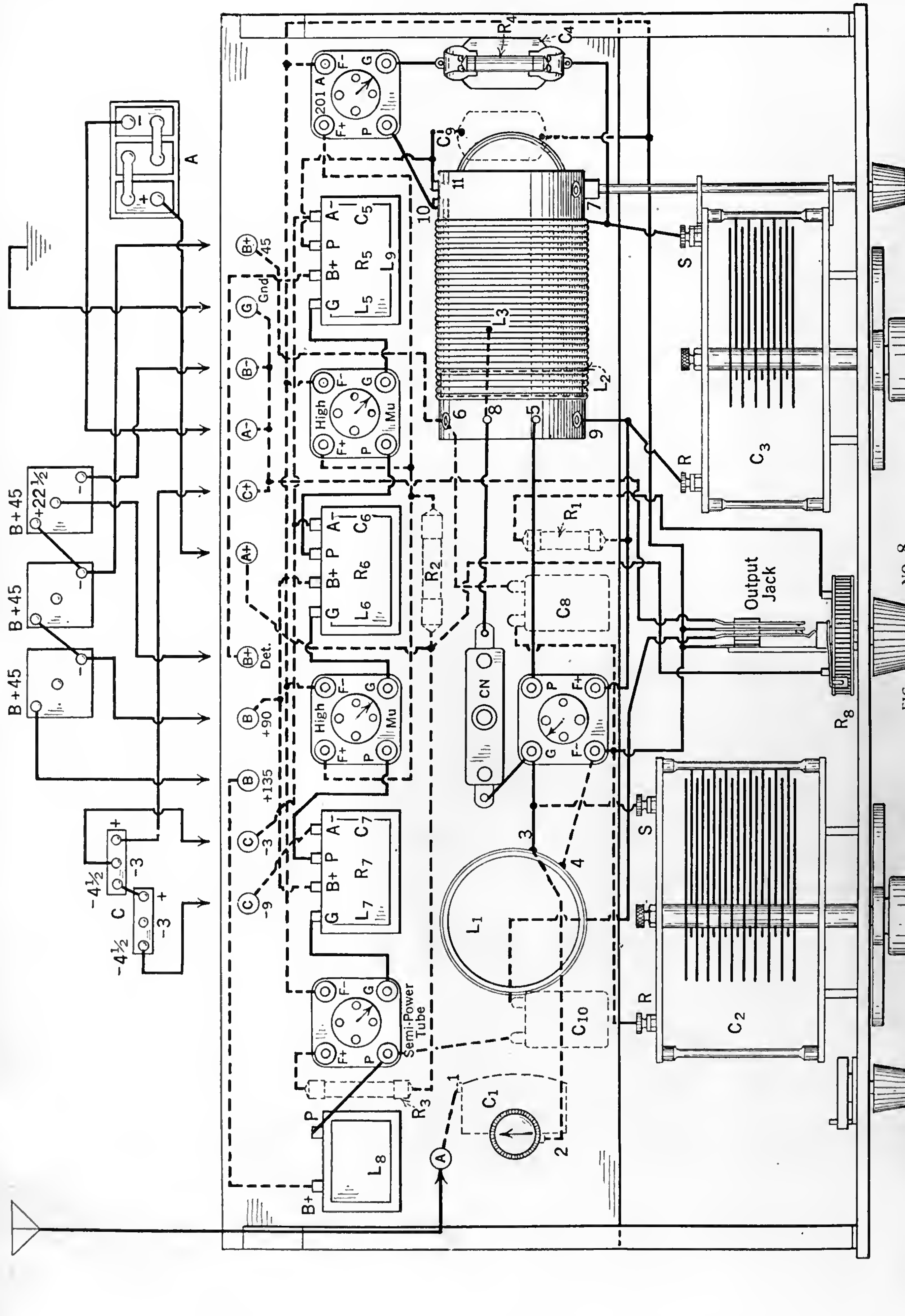


FIG. NO. 8

A picture diagram of the completed Browning-Drake receiver. The dotted lines indicate connections and wires located underneath the sub-panel. In the construction described, Lastite connectors were employed as a means for connecting apparatus above the sub-panel with that below. The parts are all indicated by letters and numerals, and by comparing with the circuit diagram, Fig. 3, and the photograph on page 403, identification may be made complete. The letters R and S on the condensers C_2 and C_3 indicate the rotors and stators

Precise antenna tuning condenser, while in the smaller is fastened the antenna binding post. At the right of the detector tuning coil unit will be observed four small holes arranged in a square. In the two near the coil is mounted the 0.005 mfd. fixed by-pass condenser C9—on the under side of the sub-panel. To its right—still looking over the front—is mounted on top of the sub-panel the grid leak and condenser C4, R4.

The only parts left are the two 1-mfd. Sangamo fixed condensers and the three filament ballast mountings. The former are mounted one to the left of the antenna tuning unit at the edge and the other to the right of the socket located between the two coil units. One of the screws holding down this socket is employed to support this fixed condenser. Of course these condensers, together with the filament ballasts, are mounted on the under side of the sub-base.

WIRING

IN THE model receiver described here, bus bar was used throughout, but others may wish to use the cable system of wiring wherein insulated wires, preferably each of a different color, are employed. Such a system has much to recommend it, as there is not the possibility of closed loops and other causes for feedback as with the bus bar style of wiring.

Small holes drilled in the sub-panel near the terminals of the various parts permit the constructor to make connections from underneath the sub-panel to objects assembled above it. The wires may pass through the holes or, if it is so desired, Lastite connectors, as illustrated, may be employed for the purpose.

The wiring and circuit diagrams are given in Figs. 3, and 8.

OPERATION

WITH the coil and condenser combination employed the receiver will readily tune from 1500 kc. (200 meters) to 545 kc. (550 meters). The approximate position of the dials, since they read alike, conforms to the frequency-wavelength chart shown in Fig. 9.

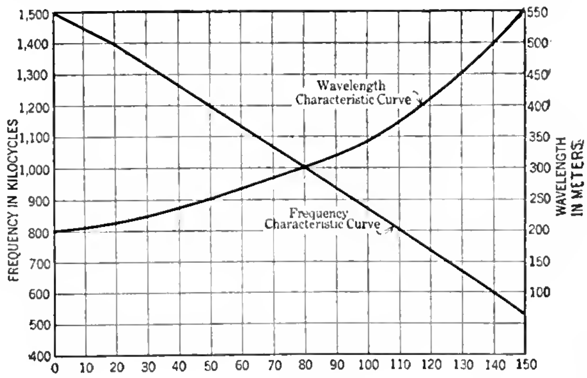


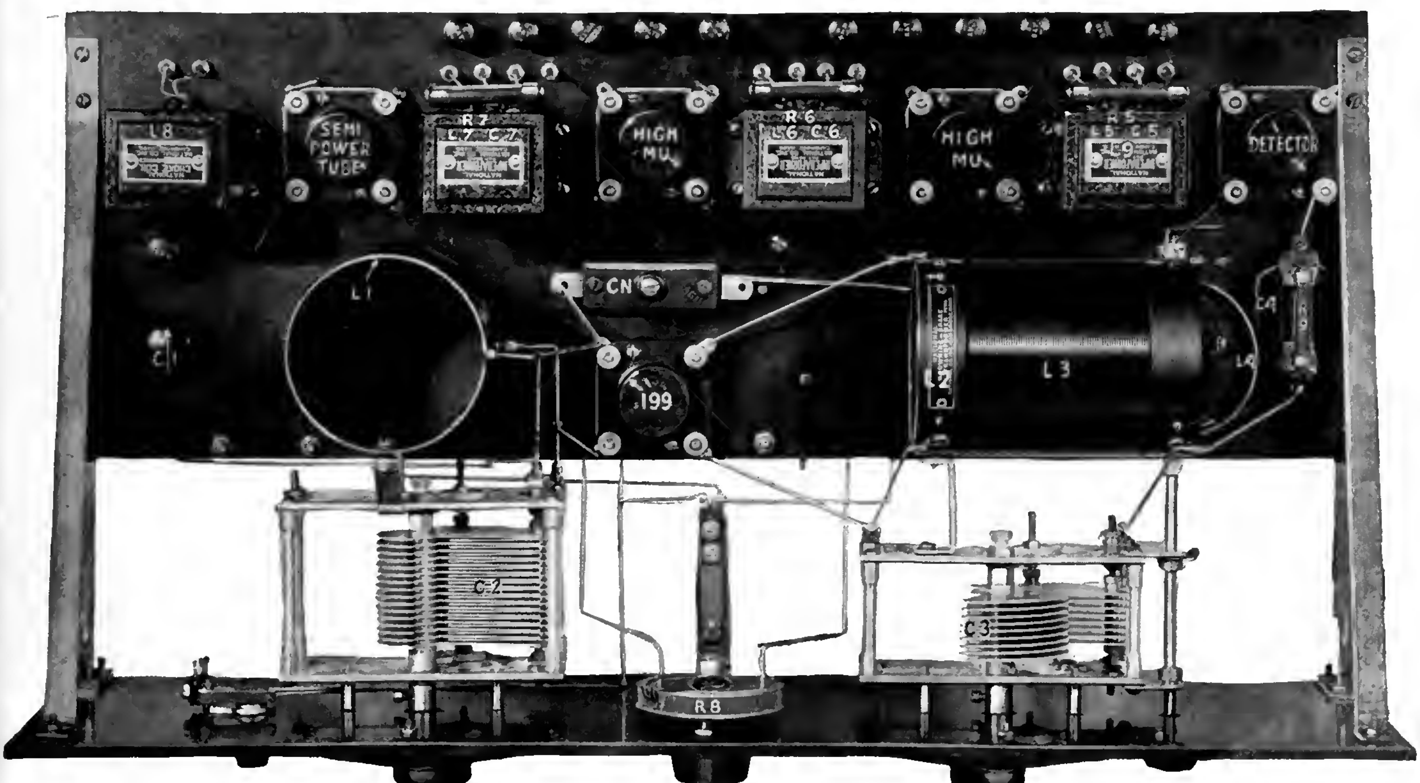
FIG. 9

Constructors will find that the tuning characteristics of their completed R. B. Impedance-Coupled Browning-Drake receiver will closely approximate the tuning curves for the National Company's coil and condenser combination shown here

Assuming that all the batteries, antenna, and ground are connected, and a pair of phones or a loud speaker plugged in the jack, proceed first to neutralize the radio-frequency amplifier as follows.

Tune-in a station—preferably a short-wavelength one, to be found at the lower readings on the dials. Then advance the tickler coil slightly until a squeal is heard. Now, by rotating the antenna coil condenser, the squeal will vary both in pitch and intensity, if the set is not neutralized. By adjusting the position of the neutralizing condenser with a piece of wood sharpened to resemble a screwdriver blade at the end, the squeal can be brought to the point where it will vary only in intensity—not in pitch. This is the point where neutralization is obtained. Another method of neutralization is to turn off the filament rheostat of the radio-frequency tube after a station has first been tuned-in—then vary the adjustment of the neutralizing condenser until the signal is either diminished to a minimum or else entirely eliminated. The antenna series condenser will be found useful in making the two main tuning dials read approximately the same over the entire scale.

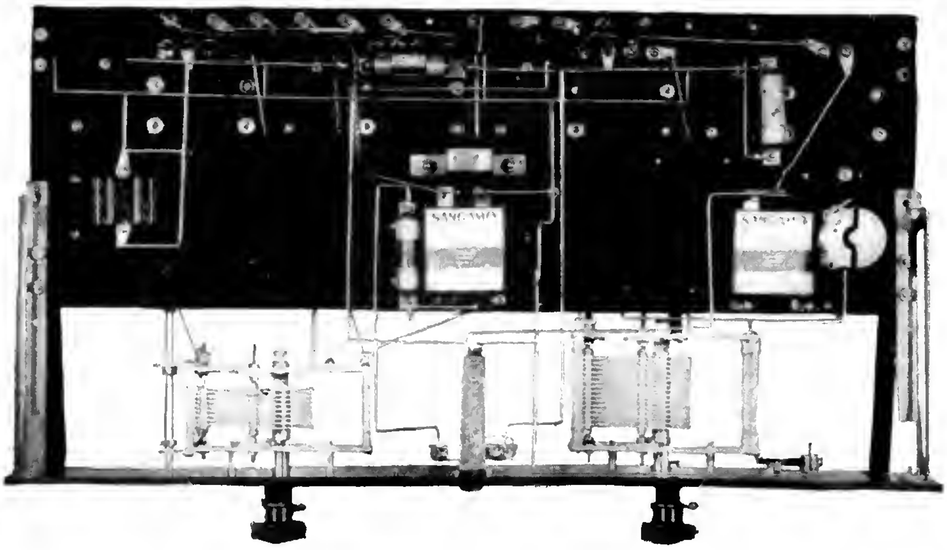
When it is intended to reduce volume, the 30-ohm rheostat inserted in the radio-frequency stage filament circuit will accomplish the desired result without any unwanted distorting effects. With some 199



RADIO BROADCAST Photograph

LOOKING DOWN ONTO THE SUB-PANEL

This photograph closely coincides with the picture wiring diagram as shown in Fig. 8 and cross reference between the two will be helpful in completing the assembly and wiring. At the time this view was taken, the older type of National dial was used; consequently, the new illuminated type is not shown. In appearance there is no great difference. Merely two contacts are provided to which connections may be made for illuminating the dial, as an aid to accurate tuning should the set be placed away from other light



THIS IS WHAT YOU'D SEE

Looking at the set from the bottom. From this view, the connections underneath the sub-panel are clear

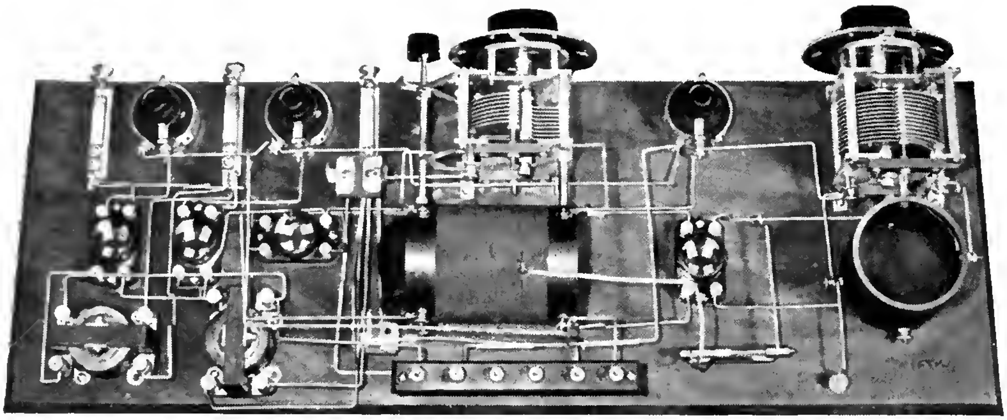
tubes, the control of volume will not be so pronounced as with others, due, most likely, to varying conditions of filament emission. If a tube is purchased which has an exceedingly high emission factor, more accurate volume control will be possible by the insertion of an additional 20-ohm resistor in its filament circuit.

Regeneration control should be smooth and not too pronounced. If this is not so, then try regulating the B battery voltages to the detector tube. The correct voltages for all the circuits are shown in the circuit diagram Fig. 3 and the wiring diagram, Fig. 8.

The radio-frequency amplifier will function satisfactorily with 45 volts of B potential. If higher values of voltage are employed, no appreciable gain will accrue and besides, neutralization will become more difficult, if not impossible.

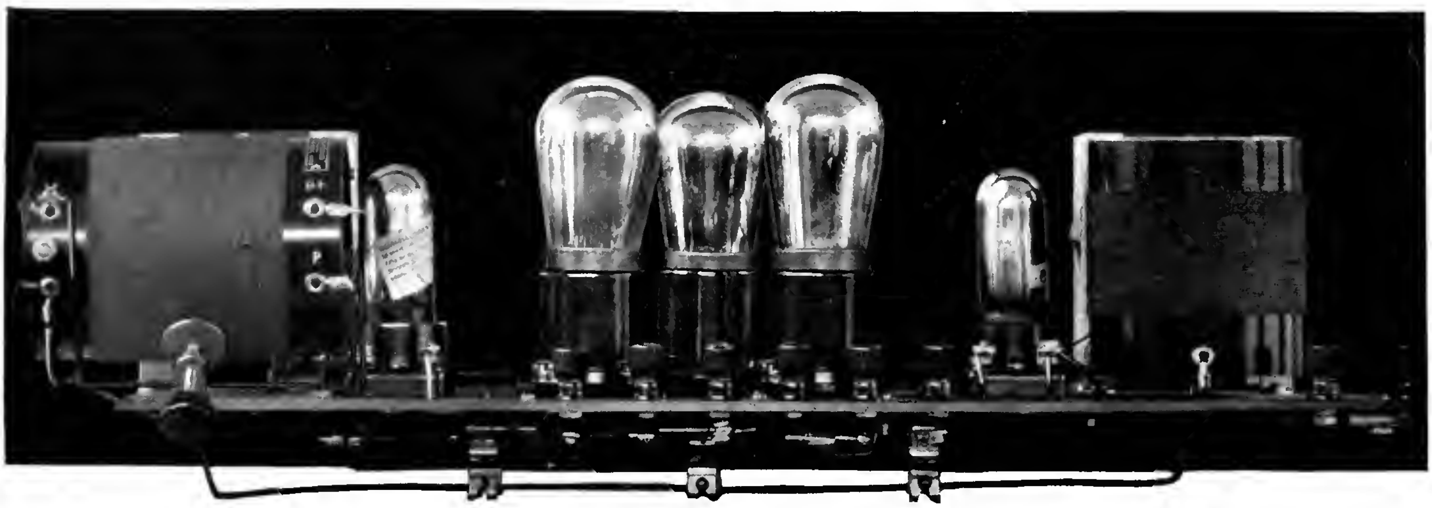
The value of grid bias applied to the audio amplifier stages is somewhat critical and it will be found in some cases that when $4\frac{1}{2}$ volts are applied to the first and second stages, the entire volume output will be reduced. With 3 volts of C battery, very pleasing tone quality with satisfactory volume is obtainable. In the last audio stage, the grid bias voltage depends entirely upon the type of tube used and its corresponding plate voltage. For a type 112 tube, 135 volts are recommended with 9 volts of C battery.

Taking advantage of the special tubes which are now procurable, results in tone quality and sensitivity may be much improved over what is ordinarily expected. This is especially true when such tubes as the Ceco special detector tube or the similar R. C. A. UV-200-A are used.



A VETERAN OF RECEIVERS

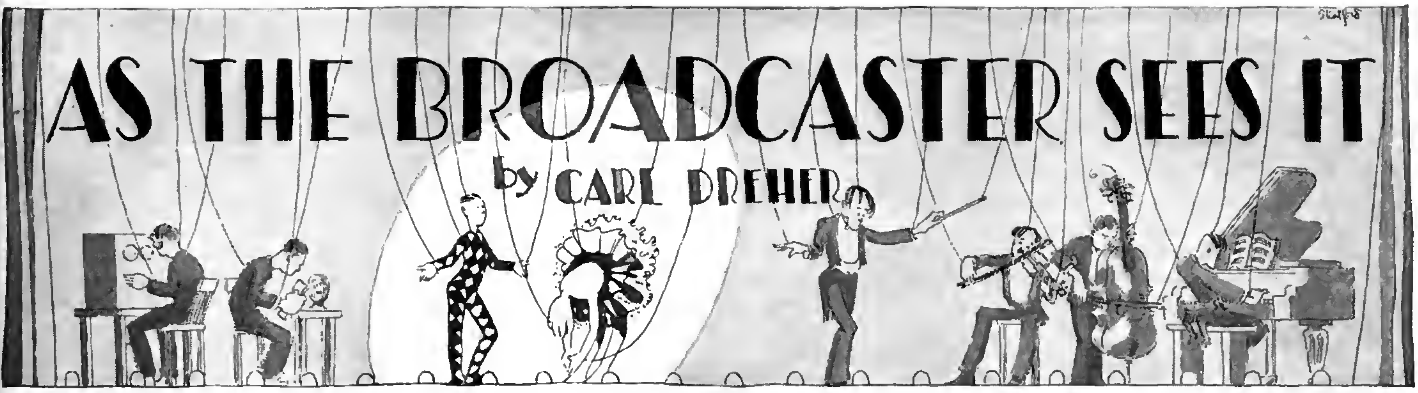
By way of comparison, this illustration of the first Browning-Drake receiver, described in the December, 1924, issue of RADIO BROADCAST, is shown. Type 199 tubes were used in every socket of this four-tube receiver. The bread-board layout gives a fair idea of the constructional and wiring details involved



RADIO BROADCAST Photographs

A RECENT MODEL OF THE BROWNING-DRAKE RECEIVER

One year later, in the December, 1925, RADIO BROADCAST, another Browning-Drake receiver of more pleasing appearance was described. Here, five tubes were employed, three being included to act in the capacity of impedance-coupled audio-frequency amplifiers. The two type 199 tubes had their filaments arranged in series so as to work directly from the six-volt filament supply. While not clearly shown, the impedance coupling units are mounted below the sub-panel. A novel form of neutralization was featured in this model whereby a small circular metal plate, about the size of a nickel, is employed as one plate of the neutralizing condenser while the metal wire comprising the secondary coil of the detector circuit forms the other plate. Adjustment is controlled by means of a threaded rod upon which the metal disc is mounted



Drawings by Stuart Hay

What About Stacking Several Broadcasters on One Wave?

ACCORDING to reports, some of the deep thinkers of the International Union which supervises European broadcasting from Geneva, goaded to desperation by the heterodyning and interference between stations which exist there as in the United States, have evolved a plan whereby a number of stations will broadcast on a common wavelength.

This scheme rests on several observed characteristics of radio telephone transmission and reception. One is that two stations will heterodyne each other with a whistling note at points where the signal of one or the other, or both, is inaudible at a given sensitivity setting of a receiver. For example, a listener may have his receiver adjusted for reception from a local station with a moderately strong signal. With the amount of amplification required under these conditions, another station 500 miles away may be quite inaudible—when the local station's carrier is off. But with the two carriers on the air, the distant transmitter may beat with the local one, producing the familiar and anathematized continuous squeal.

The pitch of this squeal, by elementary heterodyne theory, is the difference of the two combining frequencies. If one carrier is on 1000 kilocycles and the other on 999 kilocycles, the resulting note will be 1 kilocycle, or 1000 cycles. If the two carriers are on exactly the same frequency, there will be no beat note at all.

Hence, the savants argue, if we place a number of stations, well separated geographically, on the same wavelength, *accurately*, and keep them there, all will be well, and the excess of stations will be absorbed through the multiplication of stations on one wavelength. The carriers being exactly on the same frequency, there will be no beat notes, and as the stations are limited in power, direct interference of the different signals, demodulated, is precluded.

The obvious difficulty is keeping a number of carriers on one wave. And, as soon as one varies, in come the beat notes. As we know from experience, it is hard to keep stations separated by 10 kilocycles or more on their respective wavelengths. It will be even harder to keep them precisely on the same wavelength. And precisely it will have to be, or the whole scheme goes into the ash can.

Another technical objection lies in the probable interaction of the side bands. As everyone who has graduated from the radio kindergarten knows, a normal broadcasting station radiates its carrier and two side bands, the frequencies of the latter being the carrier plus and minus the modulating frequency, respectively. Even if we assume that the carriers of the stations sharing one wavelength are exactly superimposed, the side frequencies will necessarily be different, if the programs are different. We may, therefore, expect spurts of interference as these rapidly varying frequencies interact. Just how serious these interfering sounds will be remains to be seen. Judging from observations on stations whose carriers were beating with a low audible note, this difficulty would not be a minor one.

Big Tubes and Little Ones

COMPARISONS, while allegedly odious in society, are illuminating and valuable in technology. It would not do to compare a little millionaire with a big one; the little millionaire would be angry. But we may compare large and small radio tubes without offense to any one.

Technical Information Previously Printed in this Department

IN RESPONSE to requests we print a list of the previous titles and the issues in which they appeared:

Microphone Placing in Studios,	September, 1925
Outdoor Symphonic Pick-up,	October, 1925
Personnel and Organization in Broadcasting,	November, 1925
Technical Routine in Broadcasting Stations, *1. Wire Lines,*	December, 1925
Studio Microphone Placing—Further Consideration,	January, 1926
Technical Routine in Broadcasting Stations:	
2. Control Work,	February, 1926
3. Monitoring,	March, 1926
4. Multiple Pick Up,	April, 1926
5. Equalization,	May, 1926
6. Types of Equalizers,	June, 1926
7 Modulation,	July, 1926
8. Public Address Systems,	August, 1926

Water-cooled transmitter vacuum tubes, used in transoceanic telegraphy and telephony, and in large broadcasting stations, are generally rated at ten or twenty kilowatts oscillating output. It is not customary, for reasons of prudence, to undertake to get more than 10 kw. out of one unit, day in day out. The filament consumption of such a tube is about 45 amperes at 15 volts, corresponding to 675 watts. Some consume 750 watts apiece. An UX-199, which is a dry-cell detector and amplifier tube used in receivers, takes 60 milliamperes at 3 volts in the filament circuit. This amounts to 0.18 watt. Dividing 750 by 0.18, we discover that we could light 4166 UX-199's with the filament energy required for one water-cooled triode of the usual types. Allowing five tubes to the average set, it appears that we could run 833 receivers, using UX-199 tubes, with this amount of power.

At this point in my divagations, I recollect some figures from an article by Dr. Alfred N. Goldsmith, in which it is calculated that the receiving sets of the United States use 30,000 kilowatts in filament and plate power, and this Dr. Goldsmith estimates is 100 times the antenna power of all the broadcasting stations in the country. This is all I remember of the Doctor's discussion, but, as he was also comparing receivers and transmitters, I presume that I unconsciously cribbed the idea of the article I am now writing from the previous paper. Well, if so, it is not the first time I have borrowed an idea from Doctor Goldsmith. Having made this blanket acknowledgment, I may proceed.

Now, a station on the 50-kw. level uses around 32 of the water-cooled tubes aforementioned. The filament generator in the case of WJZ is rated at 23 volts and 1000 amperes, or 23 kw. Allowing 1.0-watt filament consumption for a five-tube UX-199 receiver, we now learn that this filament generator will do right by 23,000 receivers. However, no one has tried to connect even one receiver to the machine in question, which looks rather formidable. Hence I am not insisting that these figures should be taught to every school child in the United States. As an afterthought, there are two filament generators at this station, so make it 46,000, if you don't mind. Incidentally, if you went to one of the Edison Waterside power plants in New York, you could look at a few generators which would also run a lot of receiver filaments—just how many millions I hesitate to estimate. But that's not radio, so it is barred.

And now one last display of figures, before the customers fall asleep with weariness. This time I point to the UX-171, an output tube with unusually low impedance (about 2000 ohms) and a normal grid bias of minus 45 volts or thereabouts. This last figure intrigues me, because 45 volts was what I used on the *plate* of my first audion. I assembled it laboriously, using thirty $1\frac{1}{2}$-volt flashlight cells, which gave up the ghost in a lamentably short time. As for a grid bias, not even Lowenstein thought of such a thing then.

You connected the flashlight cells for your plate, lighted your filament, and let her ride! We used to short-circuit the plate battery purposely, sometimes, to admire the fat blue arc. And now it's a grid voltage!

A Lesson for the Radio Class

IF RADIO engineers, now and then, would sit at the feet of older, if not better, engineers, in the other branches of technology, and, while imbibing knowledge, construct a few analogies based thereon, it might not be a bad thing for the radio art.

The other day a large Hudson River steamer got tangled up with an oil tanker in a fog. The oil tanker went on her way. The river boat went to the bottom of the Hudson in about fifteen minutes. And, of all places, she had to founder directly over the Holland vehicular tunnel in course of construction between New Jersey and New York. Filled with water, the *Washington Irving* now rests a considerable part of her not inconsiderable weight on the structure of the tunnel bored through the silt and rock of the river bed.

When this disconcerting accident occurred, did the hair of the tunnel engineers turn white overnight? Did the wall of the tunnel crash in, filling the whole tube or sections of it with water, drowning the workers, while the design engineers went home, said good-bye to the children, and shot themselves? Not at all. Be it known, the original design of the tunnel, in addition to the usual ample safety margins provided by structural engineers, took into account the possibility of an *ocean liner* sinking over the tube. This being the case, a river steamer, with its trifling 5000 tons displacement, is nothing to worry about. The possibility of an ocean liner going to the bottom at this particular point is of course slim. But so was the chance of a large river steamer taking the plunge just there, in the 150-mile stretch between New York and Albany—and the thing happened. And the engineers had guarded against it!

What has this to do with radio? A good deal, I venture to answer. Think of the four or five years during which we radio men turned out receiving sets in which we tried tc get a big output with little tubes. Think of what that output sounded like. If we had borne in mind the first principle of the structural engineer's art—to build his bridge or his skyscraper or his tunnel ten times as strong as he has reason to believe it will ever have to be in order to stand up—would we not have had power output tubes that much sooner? Overloading and distortion in the output tube of a radio set correspond to a structural collapse in civil engineering. It is true that one crash is not as serious as the other, but they represent equally bad engineering.

Well, we have reformed. We have some pretty good output tubes these days, adequate for the work they must do, and capable of delivering several times as much volume as any sane listener will require, without distortion. But, in view of the past, I submit that we should make a low bow in the direction of our colleagues in the A. S. C. E., A. S. M. E., etc., etc.

Note on Radio Inventions

THE era of luxury is certainly upon us, in the radio field. Luxury, that is, not only in the relatively big things—period cabinets and that sort of thing, but in details of installation and control. I believe a man could build a set of five-and-ten-cent store parts today with more ease, and operate it more comfortably after it was finished, than the wealthiest amateur of ten years ago buying the best components obtainable at that time.

Such little items as battery cables and pin jack filament voltmeters are what I am thinking of. It used to be a nuisance to connect the various batteries to a set by separate wires straggling up a table leg, more or less skillfully cabled. Cutting the strands to length and skinning the ends was a little job in itself. Now you can buy a neat mercerized cotton cable with five or six individually insulated conductors, clearly color-coded, with suitable terminal lugs, for thirty-five cents, and connect your batteries to the set in five minutes, if you are slow. And it looks better and is safer when it is finished. The filament voltmeter is another blessing. It substitutes dependability and control for uncertainty. You turn the rheostat until the pointer touches the red line, and if anything changes the meter will show it. You know when your dry A-battery requires renewal. You no longer work in the dark.

I am not so enthusiastic about all radio inventions. For example, I am rather lukewarm about antenna innovations. I do not see the special virtue of metal strip in place of wire, or insulated wire as against bare. These ideas are supposed to reduce antenna resistance materially. But all they can reduce is the ohmic component of the resistance, and that is one of the smaller items. The big factor in the total resistance is the proximity of the antenna to conducting and semi-conducting masses. If the people who run their insulated lead-ins seventy feet or so along the brick walls of apartment houses would swing the conductor three or four feet out, the antenna resistance, through the reduction in the dielectric losses, would be improved ten times as much as by the use of devices for obviating corrosion or increasing superficial area of conductors. Not that these devices are harmful—they just don't matter one way or the other, in my opinion. Again, I am dubious about loud speaker volume controls incorporated in telephone plugs. Such dinguses are easily misused—the volume being throttled down at the loud speaker while the output tube overloads. The place for a volume control, logically, is ahead of, not after, the audio tubes of the receiver. Then, when the volume is reduced, the margin against output tube overloading is increased, as it should be.

Yet the inventive spirit as such is salutary. Therefore I don't like to end on a pessimistic note, and I will concede merit to the people who put up antenna wire in 150-foot coils for the longer antennas, thus obviating a splice. That is a simple and yet valuable idea.

Technical Operation of Broadcasting Stations

9. *Protection Against R. F. Pick-up*

IN SOME cities there are fifteen or twenty broadcasting stations, which is too many, viewed from several angles. They interfere with each other, not only in the listeners' sets, but even before this point. They pick up and radiate one another, not obligingly, but involuntarily. The manner of it is as follows:

One station is engaged on a pick-up job in the field. It sends out a field squad with an amplifier feeding a wire line going to the control room of this station, which we shall designate Station No. 1. The wire line runs close to Station No. 2, or perhaps the pick-up location is in a building adjacent to No. 2. Then Station No. 1 is in imminent peril of broadcasting Station No. 2. in addition to its proper pick-up. The wire line, you see, although intended for the transfer of audio currents only, is unaware of its purpose, and picks up radio frequency oscillations, often very strongly, from Station No. 2. These oscillations travel to the field amplifier of Station No. 1, where they are rectified by one or more of the tubes. If you impress a strong r. f. voltage on even a properly designed audio amplifier it will rectify more or less. The resulting a. f. reproduction of Station No. 2's program flies blithely to the modulation circuits of Station No. 1 and is radiated. Or the r. f. of Station No. 2 may go directly to the control room of Station No. 1 and succeed in getting rectified there. A third method of admittance is by way of the microphone leads of station No. 1 at the field pick-up point, rectification in the field amplifier, and so to the air once more.

The remedies are not complicated. For one thing, field amplifier boxes should be shielded

"I BELIEVE A MAN COULD BUILD A SET OF FIVE-AND-TEN-CENT STORE PARTS" with $\frac{1}{64}''$ copper sheeting. The shield, the filament battery of the amplifier, the mid-point of the output transformer line side winding, and the common posts of the carbon microphones, may then all be bonded together, and connected to a suitable ground at the remote pick-up point. This is a great aid in eliminating radio induction in an intense field at the location where the program is to be picked up. Sometimes even the microphone leads must be shielded. The Belden Manufacturing Company makes up shielded microphone cord to order. The shield forms the third conductor. The Western Electric Company also supplies shielded transmitter cord to owners of its broadcast stations.

Radio frequency traps are another device useful in guarding against pick-up from other broadcasting stations. If only one station is involved the double trap arrangement of Fig. 1, in the line, will prove effective. The shunt circuit is tuned to the station to be eliminated. This is a regular rejector trap. A number of them may be used for getting rid of the corresponding number of stations.

A neater procedure is to make up a general r. f. filter to take out all high frequency oscillations, without tuning. One such circuit, due, I believe, to Mr. Jesse Marsten, appears in Fig. 2. This may be placed in a line or microphone circuit without loss of quality due to by-passing the higher audio frequencies, but it is sure death to any radio frequencies which may be hanging about. A simpler filter is sometimes equally effective; try simply the two 150-turn coils and two 0.02-mfd. condensers with midpoint ground, if the boss is yelling about economy. But if the pick-up is very heavy you may require the whole works, as shown in Fig. 2, to get it all out.

Besides the remote control points at which filters on this order may be installed, it is well to have one at the station end in each incoming line, to block r. f. oscillations coming directly to the station. They should be placed in the line, ahead of the repeating coil.

10. *Calculation of "Gain"*

IN RADIO, the general practice has been to measure amplification in terms of voltage, current, or power. For example, we would say that under certain conditions a stage of audio amplification gave a voltage (or current) amplification of 15 times, corresponding to a power amplification of $(15)^2$ or 225 times. (The power expended or generated in a circuit always varies as the square of the voltage and current, the simplest illustration being the well known formula for the electric power, P, expended in a simple circuit of resistance R, the current flowing being I:

$$P = I^2 R$$

This energy appears as heat.)

In the telephone field, however, it has been customary to express amplification in terms of "miles gain." This method arose from the fact that telephone engineers got into the habit of expressing the loss of signal strength along a line in miles of standard cable, No. 19 gauge. "That signal is down five miles," they would say, meaning that it sounded as if it had passed through five miles of standard cable. Their datum or fixed reference mark was "zero level," corresponding to the output of a standard transmitter. When amplification was introduced, it was natural for the telephone men to express the "gain" in the same terms as the loss they were trying to overcome, that is, in miles of No. 19 cable.

Since the wedding of radio and wire telephony in broadcasting, with some of the technicians talking amplification in one language and the rest

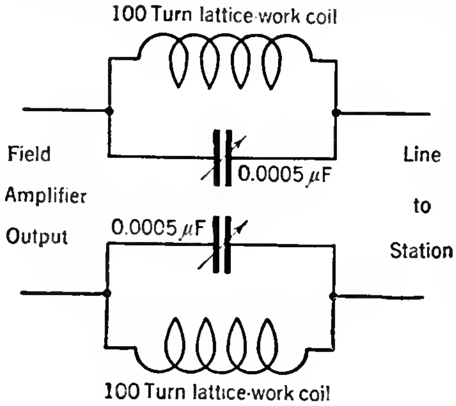


FIG. I

in the other, a certain amount of confusion has resulted. The relationship, however, is a very simple one, and there is no reason why broadcasters should not be able to convert power or voltage amplification into miles gain, if a book of logarithms or a slide rule is handy. The expression is

$$\text{Miles Gain} = 10.56 \log_{10} \frac{P_2}{P_1} \qquad (1)$$

where P_1 is the input power of the amplifier, and P_2 the output power. These powers vary as the square of the input and output voltages, as pointed out above. The mean speech frequency is assumed to be 796 cycles per second.

A single numerical example is probably sufficient to show the working of the formula:

Given a field amplifier with a voltage amplification of 200 times, what is the equivalent gain in miles of standard cable?

Solution: The power amplification of the amplifier is the square of the voltage amplification. Then we may write

$$\frac{P_2}{P_1} = (200)^2 = 40{,}000$$

Substituting in (1) above, we have

$$\text{Miles Gain} = 10.56 \log_{10} (40{,}000)$$

The log to the base ten of 40,000 may be looked up in a table of logarithms. The value is found to be 4.60206. Hence we write

$$\text{Miles Gain} = 10.5\ (4.60206) = 48.6$$

The amplifier in question therefore has a telephone gain of about 48 miles when the voltage amplification is 200 times.

This amount of amplification, incidentally, is about half the voltage amplification of a two-stage, transformer-coupled audio amplifier, allowing an amplification constant of 5. for the tubes, and a turns ratio of 5. in the first transformer and 3. in the second. The overall amplification, in terms of voltage ratio, is then 375. If we use the formula again, we find that this corresponds to a gain of 54 miles. Inasmuch as the gain in miles is a logarithmic function of the power ratio of the amplifier, the former does not increase as rapidly as the voltage ratio, and almost doubling the voltage ratio, as in this case, only adds a telephone gain of about six miles.

For purposes of mental computation, the last observation is a handy one to keep in mind. We note from the formula (1) above, and the power-voltage relation, that whenever the voltage or current amplification is doubled, the ratio P_2/P_1 is multiplied by 4. The logarithm to the base 10 of 4.0, to two places, happens to be 0.60. Inasmuch as we have a coefficient of 10.5 in the formula, this means that the increment in miles gain, for a doubling of the voltage ratio of the amplifier, is regularly 6 miles, approximately. Hence if you make a mental note of the voltage amplification and miles gain in one case, say, roughly, fifty miles gain corresponding to 200 times voltage amplification, from the above example, you can approximate the miles gain corresponding to any voltage amplification, without putting pencil to paper. For example, what is the miles gain corresponding to a voltage amplification of 3200? It is necessary to double 200 four times. Four times six is twenty-four. Add twenty-four miles to fifty and you have the answer: 74 miles. Or, going in the opposite direction, what is the telephonic gain corresponding to 25 times voltage amplification? This time you halve 200 three times, which lands you at 25, and, multiplying six by three, you get eighteen miles to substract from the fifty with which you started. The answer is 32 miles. But if the problem involves low gains, say 10 miles or under, it is well to use the formula directly, as the inaccuracies involved in the mental figuring become serious in this region.

Memoirs of a Radio Engineer.

XIV

WHEN I began this series, I prefaced it with a little explanation, which I shall now repeat for the information of the patrons who came in after the show started. My apologia for writing my radio autobiography at the age of thirty was that I wanted to set down these incidents before I forgot them. Another reason which has been brought to my notice during the writing of the articles, is that many other amateur and professional workers in radio have gone through practically identical experiences, so that the reminiscences which I am turning out are not individual, but hold more or less for the whole group. Of course my old-time stuff is largely juvenile, and there were important professional developments in progress while I was still potting the neighborhood cats with bean shooters. Mr. Marriott has written entertainingly and instructively about some of his experiences in the early history of radio telegraphy. And George Burghard, in a Radio Club of America paper, published in the August, 1923, *Radio Broadcast* under the title of "Eighteen Years of Amateur Radio," covered the rise to eminence of the West Side group of New York City amateurs. There have been other contributions in this magazine by Armstrong, Butler, Worts, Gowen, Irwin, among the rest. In short, radio men, being a group who combine romance with commerce in their profession, are strong on reminiscences, and I am following a well-established precedent. In radio we always glorify the past and look forward eagerly to the triumphs of the future; only in the present we are

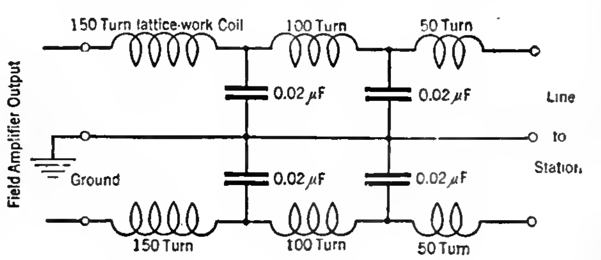


FIG. 2

full of groans and denunciations. In this we are like other people. And I am like other radio men.

We left off, in the July number, with the founding of the radio club at the College of the City of New York. Among the pieces of equipment there I recollect a long-wave regenerative receiver, with coils of annunciator wire wound on cardboard tubes about three feet long. Mr. E. T. Dickey, at about the same time (1915) had a private set of the same type, on which he let me listen to Glace Bay and other sustained wave stations. These, however, were not my first experiences with vacuum tubes. I had had one, in fact two, of my own. But they were gone. They had died, so to speak.

Nowadays janitors and poor working girls own five-tube sets, but ten or twelve years ago the possession of a single tube was a mark of distinction, among radio amateurs, equivalent to ownership of a Nubian lion by a poor Roman, say. The comparison is slightly crippled, but it has this in its favor—a Nubian lion will consume the entire income of his master, if the latter is in middle circumstances or below; and the audion bulbs did just that for the poor radio addicts of the pioneer days. First, there was the job of getting one. The early tubes were not sold outright; you were entitled to buy one only if you were the owner of an amplifier, which cost several hundred dollars for some of the models, and less, but not enough less to come within reach of the average amateur, for a single-stage outfit. However, if you brought a burned-out tube to the manufacturer, that was accepted as *prima facie* evidence of ownership of an amplifier. The company then graciously sold you a bulb for $5.00 or $7.50, depending on the type of filament. Naturally there was a thriving trade in burned-out tubes; it was almost as great a triumph to get a defunct audion as a new one, inasmuch as there was no possibility of attaining the consummation of desire without going through this preliminary step. Anyway, there was not so much difference between good and burned-out audions, the former turned readily into the latter. My first lasted about fifty hours; my second, about forty minutes. But it had an extra filament, Allah be praised. The second filament, unfortunately, while it would light, showed little merit as an emitter of electrons. The best I could do on it was NAH, the Brooklyn Navy Yard, about six miles away, and he was not as loud as on a crystal detector. I therefore rescinded my praise to Allah, and lamented bitterly and lengthily the loss of my five dollars—a Christmas present. I wrote to the manufacturer of the tube, but without obtaining satisfaction. No doubt he had his own troubles, and it is probable that he needed the five dollars as much as I did. I then tried to weld the ends of the broken filament together, by applying the battery voltage and slapping the bulb in such a manner that the ends might make contact and stick together. I have never concentrated more ardently on any problem, in the years that have passed since this audion betrayed its trust, than on that sixty-fourth inch air space which showed through the glass between the broken ends of that filament. As I gazed fixedly at the small but overpowering gap, it sometimes seemed as if it must close up in obedience to my will, but the laws of matter were not suspended in my behalf. Surrounded by the protecting vacuum, the little gap continued to flaunt its presence in my face. If I ever took any stock in faith healing, it disappeared then.

More desperate measures failed likewise.

"NOWADAYS JANITORS OWN FIVE-TUBE SETS"

One of these methods of resuscitation was to apply the voltage of a spark coil secondary to the filament terminals. Sometimes the ends would leap together and stick. In my case they did not leap together, and hence they did not stick. I used a larger spark coil, borrowed from another surgeon. I reversed the polarity. I reversed it back again. Finally I wrapped the audion in tissue paper and went back to my crystal detector. The faithful crystal took me back to its bosom, but I could not love it as before. As usual, faithfulness was unrewarded. My heart and imagination remained with the scintillating and coquettish audion. It could be unfaithful and costly, and get away with it, because of the incomparable moments it brought its admirers. For, when they were working right, the old audions were not to be despised as detectors. They were imperfectly evacuated, and their characteristic curves sometimes had kinks and loops where the rectification was first rate. It is true that the tube factory had little more control over the operating characteristics of their product than over the annual frequency of sun spots, but this element of gambling in the purchase of an audion only added to the thrills. Flung into deepest despair by the demise of a beloved tube, or the failure of a new one which never worked at all, the audion speculator would save up his pennies and plunge again.

The early vacuum tubes were rounded into graceful shapes, like a Greek vase. They were not severely rectilinear, like the standardized, uniform, efficient products of the present day. They were not made by machine, but by hand, and sometimes, apparently, the hand was not a steady one. No two tubes looked alike, and few acted alike. The innards of the creature were wide open to view, for they were not within a cylindrical plate element, as nowadays, but in flat shape. The plate was a metal tab about half an inch square, then came the zig-zag grid, somewhat askew, and then a feeble looking flat loop of wire, the filament. Insulated flexible leads issued from the bulb, the grid lead green, the plate red, and the two filament leads usually in plain rubber. It was a romantic looking object, and no mistake.

The amateurs took strange measures to increase the sensitivity of their audions. They would heat the glass tube over a Bunsen flame, until the wall softened and an indentation resulted, in order to regulate the vacuum. Another stunt was to suspend a good sized horseshoe magnet with the bulb between the poles, thus subjecting the electron stream to a magnetic field. This sometimes increased the sensitivity remarkably. Some latter-day genius is going to rediscover this trick one of these days, and have his afternoon in the radio supplements.

Some, apparently, of the more sensitive specimens regenerated in the circuits in which they were used. I recollect one I had in 1913, which brought in Boston stations in New York in daylight. This tube, like many of the audions, had chromatic qualities. When at work it glowed internally with a delicate pink-violet light, like a rather refined and emasculated Geissler tube. Irritated by strong signals, it would turn a deep blue in synchronism with the dots and dashes, so that, with the room darkened, one could read the signals visually. It was a sweet and charming companion, and I hereby dedicate this article to its memory. I regret that I never gave it a name.

Transformer-Coupled Audio Amplifiers

A Paper Delivered Before the Radio Club of America, Which Considers the Proper Design of Audio Transformers, How Their Characteristics May Be Measured and Evaluated—A Comparison Between Resistance-, Impedance-, and Transformer-Coupling

By ALFRED W. SAUNDERS

Engineer, F. A. D. Andrea Company

RADIO broadcasting of musical programs, speeches, and other matter of general interest has made tremendous advances during the last few years. Probably the only reason for public interest in the art, during its early stages, was the novelty of using the ether as a medium of transmitting programs. In the early stages of the art, the quality of a program was secondary in importance to "reaching out." Developments during recent years, however, have served to make radio as much a necessity as a novelty or luxury, with the result that quality is of prime importance to-day. Radio reception is no longer a novelty in the eyes of the public, but it is, instead, a firmly grounded institution, and like other public utilities it must meet the demands of its customers both in regard to the quality and form of entertainment to be broadcast. As one writer has aptly put it, "Radio is in every sense a public institution and should therefore be controlled by the public for the public good."

It is well known that in general the quality of the transmitted programs is far more satisfactory than the quality of those received. The economics of the situation would lead us to expect the existence of this state of affairs, since any radio receiver must be relatively cheap compared to a transmitter which serves a large number of listeners. While it is true that the quality of reception depends on a number of circuit elements, probably none is more important than the audio amplifier. However, the fact must not be overlooked that quality is also affected by the tuning characteristic of the radio-frequency amplifiers, the time constant of the grid leak and condenser combination of the detector, the loud speaker, and by overloadin any portion of this circuit. It is the purpose of this paper to outline some of the fundamental considerations involved in the design of a specific type of audio amplifier and to show how some of the desirable amplifier characteristics may be obtained in practice.

Since the performance of a transformer-coupled amplifier depends primarily upon the transformer characteristics it seems logical to start with the transformer itself. The perfect transformer has been defined by K. S. Johnson—*Transmission Circuits for Telephone Communication*, D. Van Nostrand Company as one which neither stores nor dissipates energy. That is to say, an ideal transformer has no dead resistance, no losses, and a perfect flux linkage between windings. This amounts to saying that the primary and secondary self impedances must be infinitely high with respect to the sending and terminating impedances and that each must be purely imaginary in character. Moreover, for this definition to hold, the mutual impedance must be an imaginary quantity equal to the geometric mean of the primary and secondary self impedances. The reasons for these limitations are evident from Fig. 1.

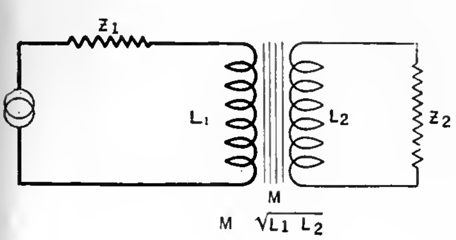


FIG. 1

If the transformer is to cause no loss in the circuit it must evidently draw zero current from the source when Z2 is infinite. Moreover, it is evident that L1 must be imaginary as well as infinite if it is to have zero loss when it draws current. The same criteria of course hold for the secondary self impedance. If all these conditions hold for a given transformer, the impedance looking into the primary will be Z2 divided by the square root of the turns ratio, where the turns ratio is given as the secondary turns divided by the number of primary turns.

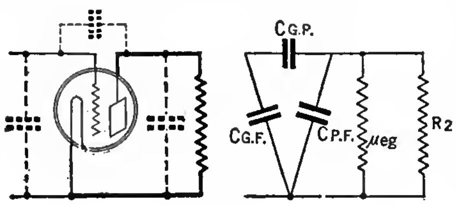


FIG. 2

THE IDEAL TRANSFORMER

EVIDENTLY then, an ideal transformer will absorb only sufficient power from the source to supply the load being drawn. Construction difficulties, however, permit us only to approach rather than realize ideal transformers in practice. That is to say, the coupling in any physical transformer is never perfect, nor are either of the self impedances infinite. The physical transformer, however, can, for all practical purposes, be considered as made up of an ideal transformer with series resistance and inductance added to take care of the dead resistance of the windings and the so-called leakage reactance. The dead resistance of the windings can usually be neglected for all except the lowest frequencies. While losses are always present in any physical transformer, proper design generally makes them negligible at all except the extremes of the transmitted frequency band. It is well known that the input impedance of a vacuum tube introduces a highly capacitative load. Fig. 2 shows the capacity and resistance network of a vacuum tube. It has been shown by J. M. Miller, *Bulletin United States Bureau of Standards*, No. 351, November, 1919, and others, that the input capacity of a vacuum tube is:

$$C = C_{G.F.} + \left\{ \frac{\mu R_2}{R_0 + R_2} + 1 \right\} C_{G.P.}$$

Since input transformers operate into the highly reactive input impedance of a vacuum tube, it is evident that the impedance reflected into the primary can match the tube impedance in magnitude at only one frequency. This is of little importance since it is only necessary to deliver a constant voltage rather than constant power to the tube input to produce a flat amplifier characteristic. It is therefore unnecessary to match impedances at all transmitted frequencies to limit distortion. See W. L. Casper, *Journal A. I. E. E.*, March, 1924.

The capacities of the transformer windings under conditions met in practice become of considerable importance at the upper extreme of the transmitted frequency band, just as the resistance of the windings in many cases plays an important rôle at the lower extreme. Fig. 3 shows diagrammatically some of these capacities. For simplicity these capacities have been shown lumped at certain points, although in reality they are distributed capacities in every case. In this diagram C_1 is the interwinding capacity, C2 and C3 the distributed capacities of the primary and secondary respectively, C4 the capacity of the inner winding to core, and Lx the leakage reactance. It is obvious that the leakage reactance can be kept small by winding the secondary next to the core with the primary over the secondary. In general, each of the above capacities are of the order of 20 to 60 micro-microfarads, depending, of course, on the construction of the transformer. The tube input impedance is represented by C5 and R5. These values are, of course, dependent on the load in the plate circuit of the tube.

ACTION OF THE TRANSFORMER IN CIRCUIT

LET us consider the action of the transformer when it is used to couple two amplifier tubes. This is illustrated schematically in Fig. 4. It is customary to represent the gain or voltage amplification of input transformers as such, rather than to rate them in terms of a perfect transformer. In this diagram, μeg represents the voltage generated in the plate circuit of the first tube, R_0 its plate impedance, and E the voltage applied to the grid of the second amplifier tube. Now it is well known that maximum power is absorbed by a given load when the impedance of the load is equal to that of the generator, and further, for a complex impedance load, the magnitude of both com-

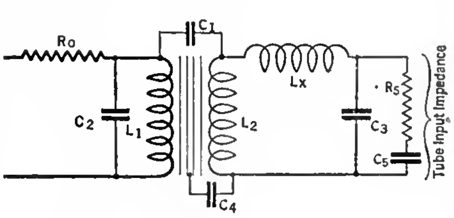


FIG. 3

ponents of the load impedance should be equal to the generator impedance, and the imaginary components of the two should be in phase opposition for maximum power transfer. As previously stated, the impedance reflected into the primary circuit can match the output impedance of the tube at only one frequency. It is obvious that if the transformer were ideal and of the proper ratio to match impedances, a flat transmission characteristic would not be obtained due to the losses on either side of the frequencies at which the impedances were matched. It has been found that it is practical to use a much lower ratio transformer than one having the ratio for optimum power transfer. It is quite common practice, too, to design transformers in which the secondary resonates with its own distributed capacity plus that of the load at frequencies less than 500 cycles. This has a tendency, of course, to increase the efficiency at these lower frequencies and in most cases it serves to further flatten the characteristic. The expression, secondary resonance, is not rigorously correct but amounts to resonance of the secondary self impedance plus the impedance reflected into the secondary by virtue of the mutual impedance of this transformer. See Pierce, *Electric Oscillations and Electric Waves*, also Casper, *Journal A. I. E. E.*, March, 1924. The ratio of the transformer is, however, determined to a certain extent by the ratio of the input and output impedances of the amplifier tubes. For this reason it is customary to use lower ratio transformers between detector and amplifier than between two amplifiers, since the output impedance of a tube functioning as a detector is in general greater than when it functions as an amplifier.

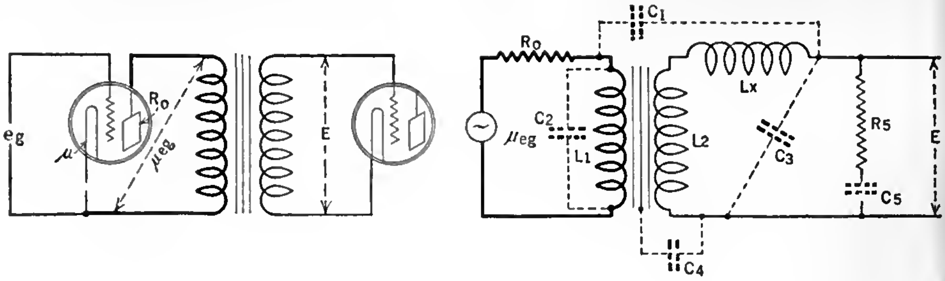


FIG. 4

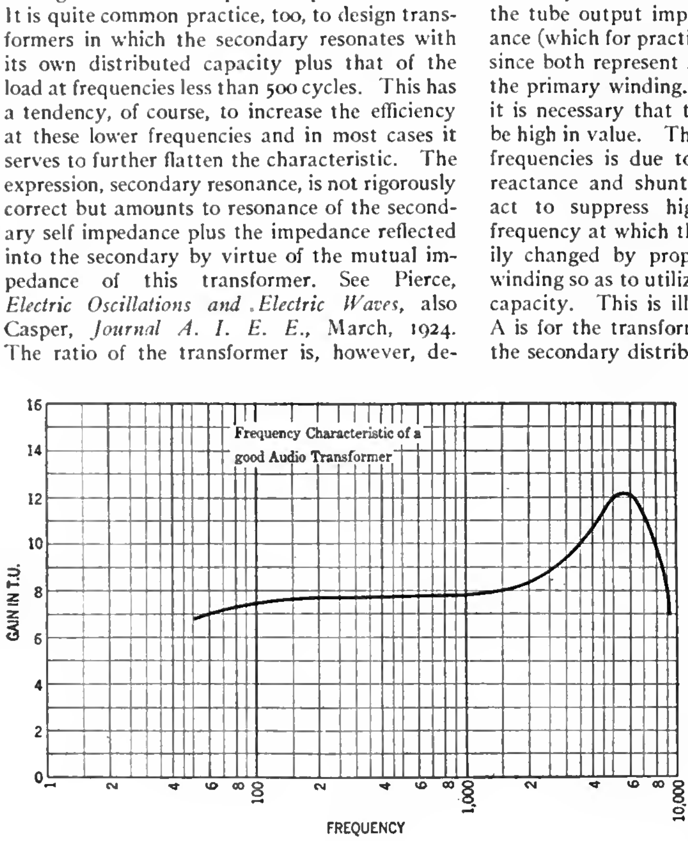


FIG. 5

The characteristic of a good audio transformer is shown in Fig. 5. The peak at the upper end of the frequency spectrum is due to resonance between the transformer leakage reactance and the tube input capacity combined with the secondary distributed capacity. The falling characteristic at the lower end of the frequency spectrum is largely influenced by the resistance and inductance of the primary winding. This would be expected because the primary self impedance increases with frequency while the winding resistance is practically a constant value. It is obvious then, that at low frequencies, the effect of the primary resistance will become more and more apparent in that it absorbs relatively much more power than at the higher frequencies.

Moreover, the primary self impedance being of the same order of magnitude as the output impedance of the tube at the lower frequencies, relatively more of the voltage drop will be across the tube output impedance and winding resistance (which for practical purposes can be lumped since both represent a dead loss) and less across the primary winding. It is for this reason that it is necessary that the primary self impedance be high in value. The sudden drop at the higher frequencies is due to the effect of the leakage reactance and shunt capacities which together act to suppress high frequency notes. The frequency at which the peak occurs can be readily changed by properly poling the secondary winding so as to utilize the secondary distributed capacity. This is illustrated in Fig. 6. Curve A is for the transformer connected so that only the secondary distributed capacity and the tube capacity are effective. Curve B represents the condition in which the secondary is poled so that the interwinding capacity or the capacity of winding to core or both are effectively added to the tube and secondary distributed capacities. It is at once obvious that the transformer characteristic can be materially altered by the simple expedient of grounding the core or reversing the secondary. The curves of Fig. 6 are almost identical with some characteristics of good commercial transformers recently measured, having a voltage amplification of about 2.5 to 1. It might be mentioned in this connection that it is difficult with ordinary core materials to obtain a good transmission characteristic with a transformer having a voltage step-up of more than 3 to 1.

DETERMINING THESE CHARACTERISTICS

THE method used in obtaining these characteristics is that in general use for this purpose. It consists essentially in the application of a constant amplitude voltage to the primary through a series impedance equal to the output impedance of the tube. The secondary is terminated in a calibrated C-battery detector. A biased d.c. micro-ammeter in the plate circuit of the tube serves to indicate changes in rectified current. Curves obtained by this method are, of course, not illustrative of the action of the transformer when it is terminated in an amplifier.

This is entirely due to the change in transformer terminations. The essential difference in the two cases is a matter of the load impedance supplied to the tube. In the case of the detector, the load impedance in the plate circuit of the tube is practically zero. Reference to the equation for input capacity will show that for the case of the detector the input capacity is relatively small while for the case of the amplifier the input capacity is relatively large, which means in the latter case we have a lower impedance. As a matter of fact, in the case of the amplifier, the input impedance consists of a resistance as well as a capacity. From this it is obvious that the transformer characteristic as taken by the detector will be changed in two respects when the transformer is terminated in the amplifier. First, the resonant peak will be at a lower frequency due to the larger capacity, and second, it will not be as sharp due to the resistance effectively added by the amplifier. This is illustrated in Fig. 7. Curve 1 is that of a characteristic measured with a detector. Curve 2 shows the characteristic of the same transformer terminated in an amplifier.

Two stages of transformer-coupled amplification might or might not give a desirable characteristic. If the tubes and the transformers are identical, it is at once apparent that the peak will be relatively very much higher for two stages than for one. This will in general result in an undesirable characteristic and may even cause singing at a frequency corresponding to the tip of the resonance peak. The most obvious way to avoid this is to stagger the transformer characteristics. This is easily accomplished by reversing one of the transformer primaries or secondaries. It is at once apparent that there are a number of combinations, each giving a different characteristic, not all of which are desirable however.

Fortunately, it so happens that the leakage

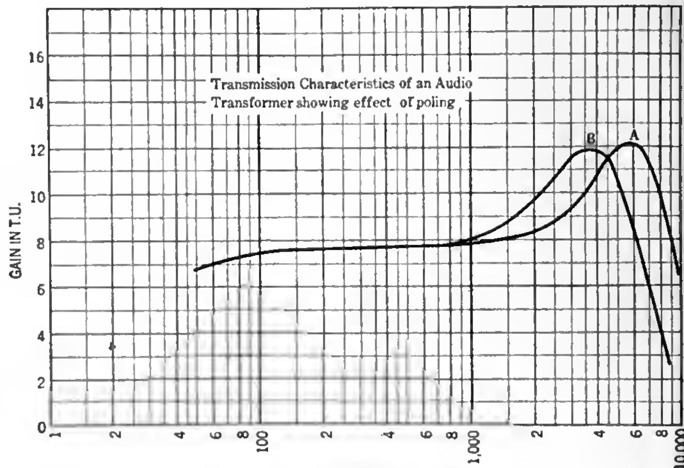


FIG. 6

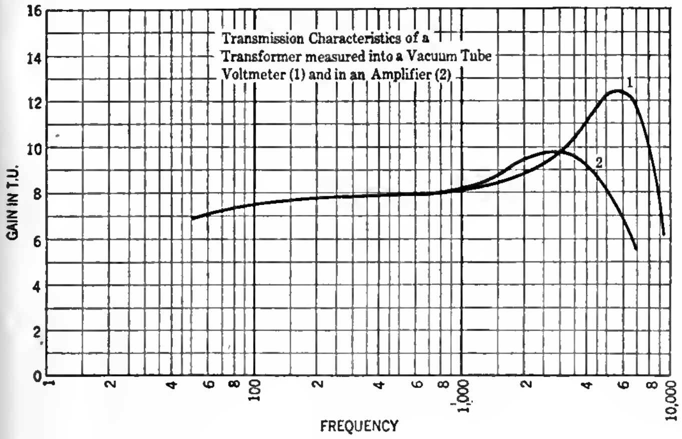


FIG. 7

reactance of the transformer can be turned to a practical use. For example, tube noises and other undesirable noises and crackles, with which all radio fans are familiar, can be very effectively eliminated without undue distortion to the transmitted signal frequency band by arranging for the leakage reactance to resonate at a frequency of about 5 kilocycles. That is to say that the amplifier characteristic will fall much more rapidly and drop much more sharply with the two stages than with either one alone. This is clearly illustrated in Fig. 8, in which Curve A is a characteristic of a two-stage amplifier arranged to obtain a flat gain characteristic. Curve B depicts the squared characteristic of one stage, while Curve C represents the squared characteristic of the other stage.

TWO TYPES OF AMPLIFIER CHARACTERISTICS

THERE are in general two types of amplifier characteristics of interest. The first is a gain-frequency characteristic, some examples of which are shown in Fig. 9 and the second is the load characteristic of Fig. 10.

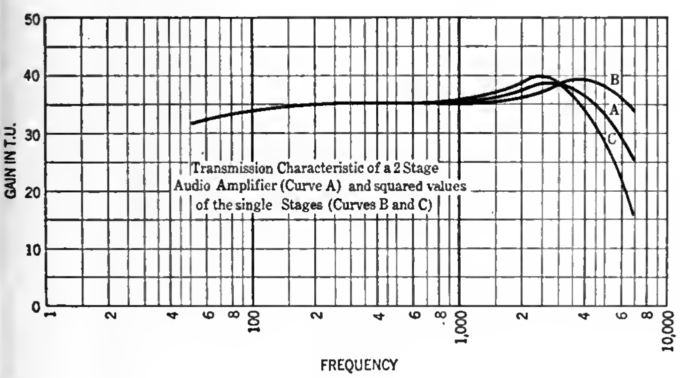


FIG. 8

Fig. 9 also illustrates what results may be expected from the simple expedient of altering transformer connections. Here the second transformer connections were left unchanged while the connections of the first transformer were varied. Curve 1 we will call normal. Curve 2 indicates the change caused by reversing the primary of the first transformer. Curve 3 shows the results of reversing both the primary and secondary of the first transformer. Curve 4 indicates the change caused by grounding the transformer cores.

The load characteristic of an amplifier, while not in such common use, is equally as important as the frequency characteristic. Overloading of tubes is the cause of serious distortion in the audio-amplifier and must be avoided if good quality is to be insured. Everyone is familiar with the grid voltage-plate current characteristics of a vacuum tube. These tube characteristics show that distortion is introduced when insufficient or too much C potential is used for a given plate potential. It is also evident that too much or too little plate potential for a given C battery introduces distortion. In general the tube functions as a grid rectifier if insufficient C battery is used, or as a plate rectifier if too much C battery is employed. (Plate circuit rectification may also occur when insufficient C battery is used, the criterion usually being the impedance of the transformer secondary.) As is often the case, the volume desired is beyond the capabilities of the last audio tube. Overloading is of course accompanied by amplitude distortion. Overloading can easily be detected by observing the plate current of the amplifier tubes. Any change in the plate current of an amplifier tube indicates that overloading and distortion are taking place. Grid rectification predominates when the plate current decreases. This can easily be remedied by increasing the C potential employed or by decreasing the plate potential. If the plate current increases, plate rectification is taking place. This may be remedied by decreasing the C potential or increasing the plate voltage. Overloading tends to cut down the gain of an amplifier because of the presence of the generated harmonics. The energy which is used to supply the overtones might just as well be used to supply the fundamental. It is true that more volume may be obtained in some cases when the amplifier is overloaded, but the desired fundamental is usually materially decreased.

Considerable information is obtained from the load characteristic of an amplifier. It expresses the relation between transmission gain and output power. It clearly indicates the overload point of an amplifier and also the maximum output level possible without serious overloading.

A common definition of transmission gain follows:

The transmission gain caused by the insertion of an amplifier in any circuit is measured directly by the ratio of the power delivered to the load when the amplifier is in the circuit and when it is removed. Having decided upon a definition of transmission gain, measurements may be made to conform with this definition, which is similar to that commonly employed in telephone practice. An input voltage is applied to the amplifier input through a resistance corresponding to the output impedance of a detector tube, and the output of the amplifier is terminated in a resistance which matches the a.c. output impedance of the last tube. This is the condition under which maximum power is delivered to the load. Gain is measured in terms of the ratio of the power delivered by the amplifier to the power which would be delivered without the amplifier. When gain characteristics of the amplifier are measured, the input frequency is varied and the input voltage maintained constant. The load characteristic was measured by maintaining a constant frequency and varying the amplitude of the input voltage.

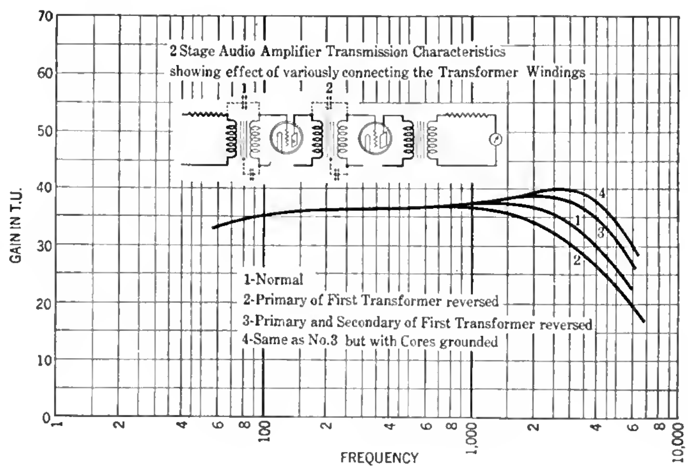


FIG. 9

COMPARING RESISTANCE-, IMPEDANCE-, AND TRANSFORMER-COUPLING

PRIOR to the development of high quality audio-frequency transformers, resistance- and impedance-coupled audio-frequency amplifiers led the field in quality. The advent of high quality input transformers and better

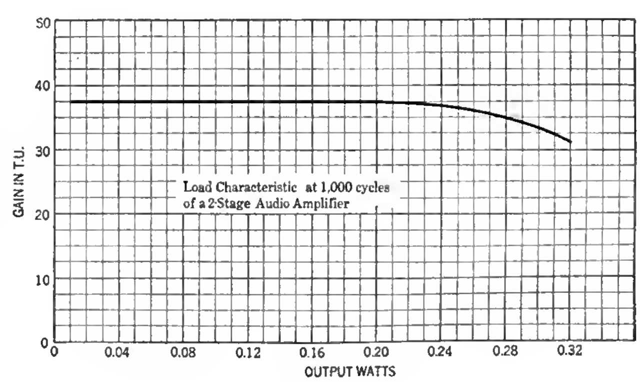


FIG. 10

acoustic translating devices, however, have all but made such devices obsolete. They represent one of the first steps toward better quality, and during the early stages of the art served their purpose. The limitations of both these types have been admirably pointed out by Mr. J. L. Schermerhorn, as follows: "An impedance- or resistance-coupled amplifier cannot be perfect. If the fixed condensers are not sufficiently large, the bass notes are missing. If they are large enough to pass the bass notes, they tend to introduce a time lag in the circuit. These conditions fix a definite limit for preventing the absolutely uniform amplification of all the audio frequencies." The time lag mentioned by Mr. Schermerhorn refers, of course, to the time constant of the condenser-resistance combination on the tube input. The minimum value of the series coupling-condenser is obviously fixed by its reactance to low notes. Now the time constant of the resistance-condenser combination must necessarily be low in order to prevent disagreeable hangovers which may either seriously alter the phase relations of independent notes or even cause some of the higher notes to disappear entirely, or be seriously masked by some of the higher amplitude low frequency notes. Inspection of the discharge curve of a condenser through a resistance would lead us to suspect this state of affairs. The product of the shunt resistance into the series capacity yields the length of time necessary for the condenser to lose about 63 per cent. of its charge. To prevent hangovers, it is necessary that the condenser discharge in less than a quarter cycle of that frequency which is the reciprocal of the time constant of the coupling combination. This of course imposes such a severe requirement on the amplifier that it would result in an overall transmission loss thereby defeating the purpose of the device. Hence it is necessary to affect a compromise between gain and distortion, and design the amplifier accordingly. The table in the next column shows a few values of time constant and their corresponding frequencies:

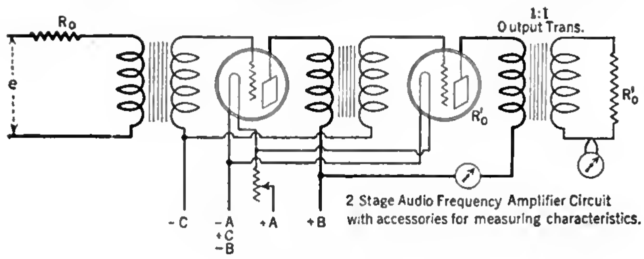


FIG. 11

C mfd.	At 50 cycles Xc ohms	R ohms	RC sec.	F c.p.s.	¼f. c.p.s.
1.0	3,180	10^6	.1	1	.25
		10^5	.1	10	2.5
		10^4	.01	100	25.0
0.1	31,800	10^6	.1	10	2.5
		10^5	.01	100	25.0
		10^4	.001	1,000	250.0
0.01	318,000	10^6	.01	100	25.0
		10^5	.001	1,000	250.0
		10^4	.0001	10,000	2,500.0
0.001	3,180,000	10^6	.001	1,000	250.0
		10^5	.0001	10,000	2,500.0
		10^4	.00001	100,000	25,000.0

In the above table, RC is the time constant of the resistance-condenser combination, in seconds, F the frequency having a period equal to the time constant, and ¼f, the highest frequency that will be unaffected by hangovers. It will be observed that an exceedingly low resistance must be used across the tube input if a reasonable time constant is to be maintained with a coupling condenser large enough to pass the low notes without undue attenuation. There are, of course, a number of other factors that enter, such as change in the gain frequency characteristic with the applied input voltage, etc. These facts are such general knowledge, however, that they merit no further discussion here. Two-stage transformer-coupled amplifiers, on the other hand, can easily be designed to give an overall amplification varying less than 40 per cent. from the average value for all frequencies between 50 and 5000 cycles.

To summarize: A perfect transformer has been defined as one which has perfect coupling and which neither stores nor dissipates energy. It has also been shown that it is desirable that a good input transformer depart from this definition since it is required that the input transformer deliver constant voltage rather than constant power. Furthermore, it is obvious that the leakage reactance can in some cases be used to advantage in eliminating high frequency noises by connecting the transformers in such sense that the inherent capacities resonate the leakage reactance at the proper frequency. A transformer characteristic as commonly measured by a C-battery detector does not give the true picture of its action in an amplifier, due mainly to the different input impedance of the amplifier tube. The general tendency of the amplifier tube is, of course, to decrease and broaden the resonance peak and to cause it to occur at a lower frequency. Transmission gain has been defined as the ratio of the power delivered to the load with the amplifier in the circuit to the power delivered with the amplifier removed. A method of measuring amplification conforming with this definition gives a truer picture of amplifier operation than the voltage amplification as ordinarily measured. There are, in general, two types of characteristics necessary to completely define amplifier operation. The first is the gain-frequency characteristic and the second the load characteristic. The former indicates the frequency distortion while the latter shows the load carrying capacity.

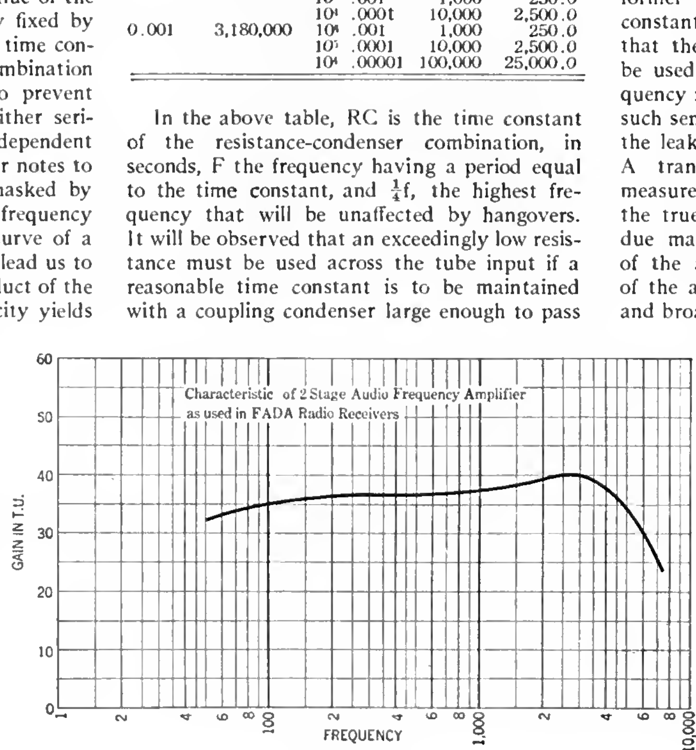
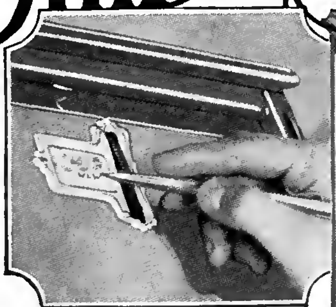
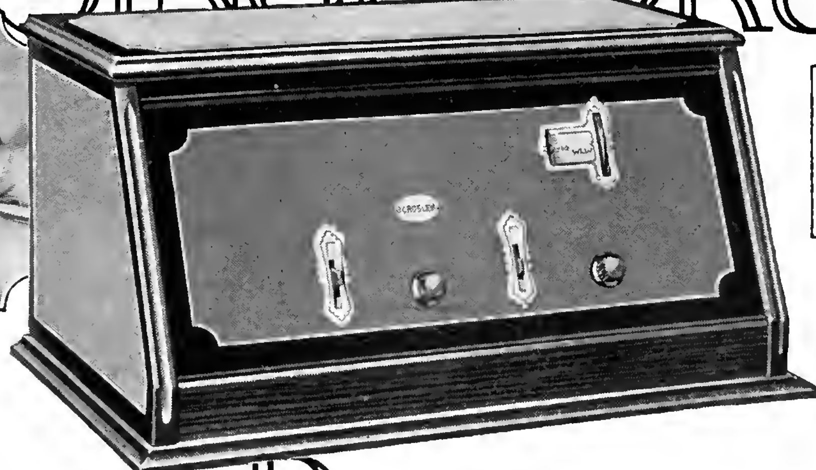


FIG. 12

This paper by Mr. Saunders is the third of a new series, printed through the courtesy of the Radio Club of America. Radio Broadcast *is the official publication of that organization and all papers delivered before the Club appear in this magazine. We, of course, do not assume responsibility for controversial statements made by authors of these papers. Readers of* Radio Broadcast, *we are sure, welcome the opportunity to read the papers presented by the Radio Club and we are very glad to have the opportunity to publish them regularly. Other Radio Club papers will appear in subsequent numbers of the magazine.*

5 tube SINGLE DRUM





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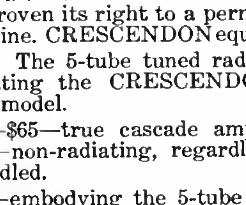

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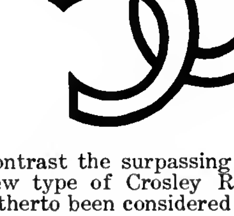

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INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has now been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," we present herewith a series of Laboratory Information Sheets. These sheets contain much the same type of information as has appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 440 of this issue. The June, July, and August issues of RADIO BROADCAST, *in which appeared the first few sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company.*

No. 25 RADIO BROADCAST Laboratory Information Sheet September, 1926

Modulation

THE HEISING METHOD

THE process of impressing audio frequency current on the radio frequency output of a transmitter is called "modulation."

The simplest case of modulation occurs when a pure note of single frequency, such as is produced by a tuning fork, is transmitted. If the tuning fork is struck and is placed near the microphone, the sound produced by the fork will be transmitted by the microphone to the radio transmitter. These audio-frequency currents will cause the radio-frequency wave to vary in amplitude and also in frequency. If the radio wave without any modulation had a frequency of 500,000 cycles, and a 1000-cycle note was produced by the tuning fork, the radio-frequency wave would change in frequency and would be composed of three frequencies; one equal to the original frequency of 500,000 cycles, another equal to 499,000 cycles; and another equal to 501,000 cycles.

These latter two frequencies are equal, respectively, (1.) to the difference between the original, or carrier frequency, and the audio frequency, and (2.) the sum of the carrier and audio frequency. In actual transmission, we are not dealing with a single 1000-cycle note but are dealing with the entire band of frequencies between approximately 50 and 5000 cycles, so that all of these various frequencies are impressed on the carrier wave during modulation.

The most common method of modulation used by broadcasting stations is the Heising method, and it is shown in its elementary form in the diagram on laboratory Sheet No. 26. Here tube No. 1 is the oscillator, and No. 2 the modulator. Choke coil L is sometimes called the Heising choke. The oscillatory circuit is the familiar Hartley type using an inductively coupled antenna coil.

The voice signals are impressed on the grid of the modulator tube as is shown in the diagram. Actually, between the microphone and the modulator tube, it would be necessary to use several stages of additional amplification. These audio signals impressed on the modulator cause its plate current to vary and produce a corresponding plate-current variation in the oscillator tube.

The total current supplied to the circuit by the battery supply, marked B on the diagram, does not vary appreciably as the modulation is impressed on the grid of the modulator tube No. 2, due to the fact that the choke coil has a very high inductance and, therefore, offers considerable impedance to any variation in the current flowing through it. This Heising choke coil is an essential part of a radio transmitter using this type of modulation.

If a radio wave is completely modulated, the power transmitted will be about one and a half times as much as an unmodulated wave having the same average current. However, in ordinary broadcasting, it is not advisable to completely modulate the carrier and, therefore, it can be said that the power transmitted when the wave is being modulated is about the same as the power transmitted when the wave is not being modulated.

No. 26 RADIO BROADCAST Laboratory Information Sheet September, 1926

The Three-Electrode Tube

ITS VARIOUS FUNCTIONS

THE three-electrode tube can be used in a great many ways, but its use in connection with radio transmission and reception is confined almost exclusively to the following:

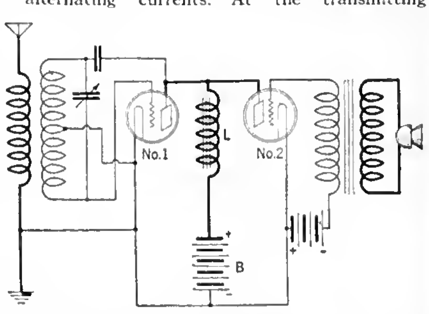
1 MODULATION: Vacuum tubes are used in this connection in all the large radio broadcasting stations throughout the world. Modulation can be defined as the process of varying the amplitude of the transmitted radio waves in accordance with the variations of air pressure that constitute the voice or music. The actual process of modulating the power of a high-power station, in general, requires considerable essential auxiliary apparatus. However, modulation can be accomplished using a single circuit such as that shown in the accompanying diagram, where tube No. 2 is the modulator. A careful analysis of modulation appears on Sheet No. 25.

2. DETECTION (also called RECTIFICATION and DEMODULATION): This is the process of converting modulated radio-frequency alternating currents into direct currents varying in strength in accordance with the original voice or music.

3. REGENERATION: The process of neutralizing some of the unavoidable resistance in the receiving circuits, resulting in greater currents being produced by the incoming waves.

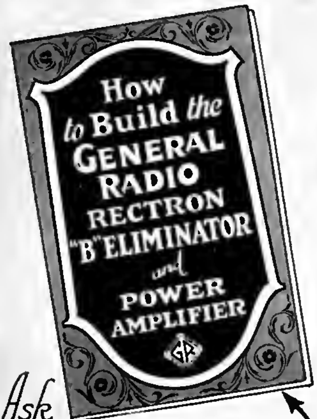
4. AMPLIFICATION: Increasing the energy of either radio- or audio- (voice and music) frequency currents, without changing their form. The tube itself is an amplifier, the ordinary type giving an output voltage about seven times greater than the input voltage. The tube may function in conjunction with a transformer, in which case an even greater overall amplification is obtained.

5 OSCILLATION: The production of high-frequency alternating currents. At the transmitting



stations it is high frequency current flowing in the antenna that radiates energy in the form of electromagnetic waves (in this case, radio waves). Tube No. 1 is an oscillator in the diagram shown.

Not "How Far?"
Not "How Many Stations?"
But "HOW REALISTIC?"
is now the pertinent question of radio



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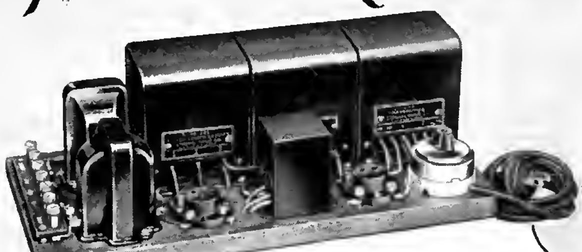
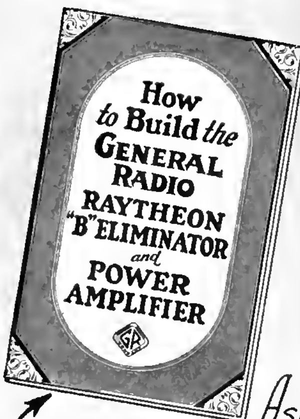




Ask your dealer or write for this folder

THE spell of magic in radio is over. No longer are we mystified by programs from far off cities. No longer do we spend whole evenings in dial fishing for all the stations we can get—just for the sake of boasting a long list of call letters.

Today we are in a new era of radio—one of quality reproduction. Broadcast listeners everywhere are demanding above all else reception that is natural.

If your radio customers have not yet modernized their receiving sets, by the improved type of loudspeaker, better transformers, "B" voltage supply units and power amplifiers, they cannot appreciate what clear, sweet-toned music athrob with human expression is in store for them.

This is going to be a big year for TONE QUALITY. Be prepared to sell your customers devices that improve TONE QUALITY. Show them the new General Radio "B" eliminator and Power Amplifier kits, that can easily be assembled in a single evening. Tell them about the new type 285D transformer, and type 387 Speaker Filter.

Ask your distributor or write us for full information on these new General Radio products.

GENERAL RADIO CO. Cambridge, Mass.

The Type 285-D
Audio Transformer
has a high impedance to match the output of the new 200-A detector tube. When used in the first stage of audio amplification following the 200-A the 285-D produces a very marked improvement in tone quality.
Price $6.00

★

The Type 387
Speaker Filter
adapts the impedance of the amplifier to the Western Electric and other cone speakers of similar design and quality so that unusual purity of tone is produced. It has a very wide frequency range.
Price $6.00

GENERAL RADIO PARTS
Behind the Panels of Better Built Sets

No. 27 RADIO BROADCAST Laboratory Information Sheet September, 1926

A Voltmeter Made From a Milliammeter

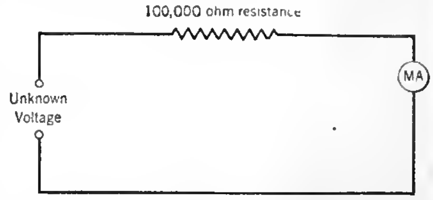
CALCULATING THE NECESSARY RESISTANCE

IN THE course of their experiments, most home constructors acquire one or more d. c. milliammeters for use in measuring the plate current of tubes. These instruments are comparatively cheap and are essential in making general tests on radio parts.

Another very useful instrument is the d. c. voltmeter for use in measuring the voltage of all kinds of batteries and line supply devices. It is possible to make up a very useful and fairly accurate voltmeter using a milliammeter and a good fixed resistance, and thereby make unnecessary the purchase of a voltmeter. Actually, a voltmeter consists of a sensitive milliammeter in series with a high resistance. In calibrating, such a meter, in series with the resistance, is placed across known voltages, and its scale marked off in volts instead of milliamperes.

Suppose we have a meter with a full-scale reading of 2 milliamperes (.002 amperes), and we want to use it as a voltmeter for use on line supply devices which supply voltages up to 200. To determine the required resistance necessary in series with the meter, we divide 200 by .002, and the quotient, 100,000, is the required resistance in ohms. If we place the milliammeter in series with the 100,000-ohm resistance across an unknown voltage, as shown in the diagram, the needle will deflect an amount proportional to the voltage. We have made our voltmeter so that if the meter reads 2 milliamperes the voltage is 200. Now, if the meter reads 1½ milliamperes, the voltage is 150; if it reads 1 milliampere, the voltage is 100, etc.

It is not always possible to obtain accurate resistance units so that it is, in general, wise to calibrate the voltmeter so as to allow for errors in the fixed resistance. On Sheet No. 28 is given information regarding the calibration of a home-made



voltmeter, and if the calibration is done carefully, it should be possible to obtain readings which will be accurate within a few per cent. For rough measurements, no calibration is necessary since, if good fixed resistances capable of passing several milliamperes are purchased, their marked resistance value can be depended upon within about ten per cent., and usually the per centage error will be even less than this.

No. 28 RADIO BROADCAST Laboratory Information Sheet September, 1926

Calibrating a Home-Made Voltmeter

PLOTTING THE CURVE

ON LABORATORY Sheet No. 27 were given data regarding the construction of a simple voltmeter from a milliammeter. Information is given here for the calibration of such a meter.

First determine the required resistance in series with the milliammeter by the following formula:

$$R = \frac{E \times 1000}{I}$$

where E is the maximum voltage it is desired to read, I is the full scale reading of the meter in milliamperes, and R the unknown resistance.

Examples:

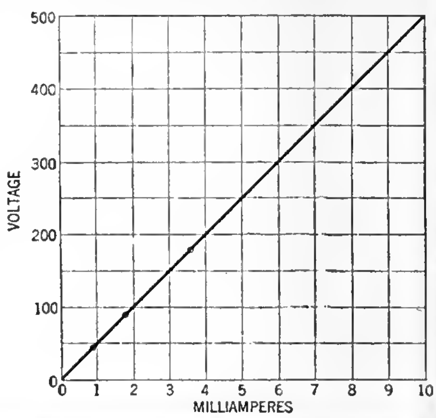
1. It is desired to read 500 volts using a 10-milliampere meter.

$$\text{Then } R = \frac{500 \times 1000}{10} = 50{,}000 \text{ ohms.}$$

The calibration is performed by placing the fixed resistance and meter across different known voltages and plotting a curve showing the deflection of the meter for different values of voltage.

By making such a calibration, it will be possible to compensate for any inaccuracy in the fixed resistance. If no voltmeter is available whereby the applied voltages for calibrating purposes can be measured, it will be possible to use new B Batteries, since the marked voltages will then be quite dependable. First 22½ volts could be placed across the combination and the meter reading taken, then 45 volts, etc., until several points are obtained.

It will not be necessary to calibrate the full scale of the meter since the calibration will be a straight line. The abscissa, or horizontal axis, of the curve should be plotted in milliampere deflections, and the ordinate, or vertical axis, should be plotted in the corresponding voltages. Such a curve is illustrated on this Sheet.



No. 29 RADIO BROADCAST Laboratory Information Sheet September, 1926

Tubes: Miscellaneous

UX-213

This is a full-wave rectifier for use with line supply devices. Its filament voltage is 5, and it takes a filament current of 2 amperes at this voltage. The maximum value of the a.c. input voltage is 220 volts (effective value), and the maximum rectified current the tube can deliver is 65 milliamperes.

UX-216-B

This tube is a half-wave rectifier for use in line supply circuits. Its filament voltage is 7.5, and current is 1.25 amperes. The maximum value of the a.c. input voltage is 550 volts (effective value). The maximum rectified current is 65 milliamperes.

UX-874

This tube is used as a voltage regulator and, when correctly connected in a circuit, it functions to maintain a constant voltage. The voltage drop is 90 volts d.c., and the starting voltage is 125 volts d.c. The maximum current is 50 milliamperes d.c. The positive lead is connected to the rod and the negative lead connects to the cylinder. This tube is used in the line supply device manufactured by the Radio Corporation of America and also in their Model 104 loud speaker.

UV-876

This is a ballast tube and when correctly connected in a circuit it functions to maintain constant current. It has a current rating of 1.7 amperes, and the voltage drop is 40 to 60 volts. This tube is designed for use on units using 105 to 125 volts supply at from 50 to 75 cycles.

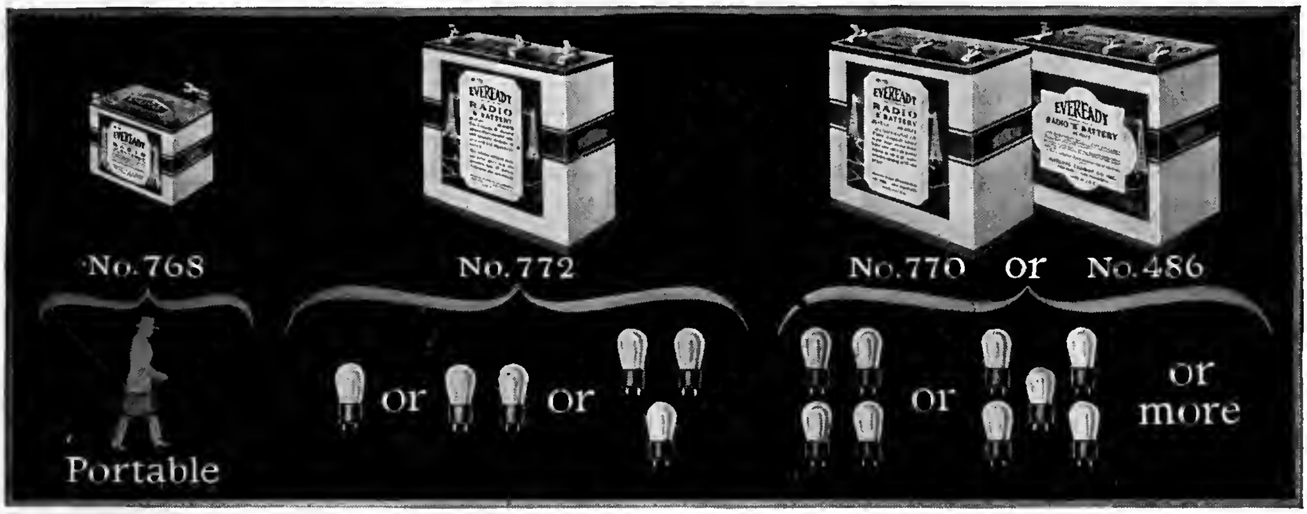
UV-886

This tube is practically the same as the model UV-876 except that it is for use on from 40- to 45-cycle current. It has a current rating of 2.05 amperes, and the voltage drop is from 40 to 60 volts.

UV-877

This is a protective tube, and is used in the *B* battery circuits of receivers to prevent damage to tubes or wiring, if the B batteries are accidentally short-circuited. The voltage drop across half the filament is 2.5 volts at 20 milliamperes d.c., and rises to 45 volts at 90 milliamperes d.c. Across the entire filament, the voltage drop at 20 milliamperes is 5 volts. With 90 milliamperes flowing through it, the voltage drop is 90 volts. From these figures it is evident that, if the B batteries are accidentally short-circuited, practically all the voltage will be consumed by this tube, and the current definitely limited to a safe value.

Perhaps you, too, can cut your "B" battery costs in half. Just follow the chart. It gives you the secret of "B" battery economy.



THOUSANDS of people have made the discovery that Eveready "B" Batteries, when used in the proper size, and on sets equipped with a "C" battery*, are a most economical, reliable and satisfactory source of radio current.

Here is the secret of "B" battery economy, reliability and satisfaction:

On all but single tube sets—Connect a "C" battery. The length of service given below is based on its use.*

On 1 to 3 tubes—Use Eveready No. 772. Listening in on the average of 2 hours daily, it will last a year or more.

On 4 or more tubes—Use the Heavy-Duty "B" Batteries, either No. 770 or the even longer-lived Eveready Layerbilt No. 486. Used on the average of 2 hours daily, these will last 8 months or longer.

These figures are based on the average use of receivers, which a country-wide survey has shown to be two hours daily throughout the year. If you listen longer, of course, your batteries will have a somewhat shorter life, and if you listen less, they will last longer.

Eveready's give you their remarkable service to the full only when they are correctly matched in capacity to the demands made upon them by your receiver. It is wasteful to buy batteries that are too small. Follow the chart.

In addition to the batteries illustrated, which fit practically all the receivers in use, we also make a number of other types for special purposes. There is an Eveready Radio Battery for every radio use. To learn more about the entire Eveready line, write for the booklet, "Choosing and Using the Right Radio Batteries," which we will be glad to send you on request. There is an Eveready dealer nearby.

Manufactured and guaranteed by
NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

Tuesday night means Eveready Hour—8 P. M., Eastern Standard Time, through the following stations:

WEAF–*New York*
WJAR–*Providence*
WEEI–*Boston*
WTAG–*Worcester*
WFI–*Philadelphia*
WGR–*Buffalo*
WCAE–*Pittsburgh*
WSAI–*Cincinnati*
WTAM–*Cleveland*
WWJ–*Detroit*
WGN–*Chicago*
WOC–*Davenport*
WCCO { *Minneapolis* / *St. Paul* }
KSD–*St. Louis*

*NOTE: A "C" battery greatly increases the life of your "B" batteries and gives a quality of reception unobtainable without it. Radio sets may easily be changed by any competent radio service man to permit the use of a "C" battery.

EVEREADY ★
Radio Batteries
they last longer

★ Tested and approved by RADIO BROADCAST ★

No. 30 RADIO BROADCAST Laboratory Information Sheet September, 1926

Measuring the Output Voltage of a Line Supply Device

REQUIREMENTS OF A SUITABLE METER

CONSIDERABLE care must be taken in measuring the output voltage of a line supply device if an accurate reading is to be obtained. The output voltage of such devices depends to a great extent upon the current being drawn from them, and if any considerable amount of current is also drawn by the voltmeter which is used in determining the output voltage, the reading will not be accurate and cannot be used.

Also, if true results are to be obtained, the output voltages must be measured when the instrument is connected to the receiver and a normal load is being drawn from it, since, if these conditions do not exist at the time of the test, the voltage read with the voltmeter will be considerably higher than would actually be applied to a receiver during operation. A reading taken without any load on the line supply device will sometimes be 100 volts higher than the reading taken with load.

The voltmeter used to measure the output voltage must have a very high resistance in order to prevent large currents from flowing through it. On Sheet No. 27 is given information regarding the construction of a home-made voltmeter which can be used.

It is also possible to purchase suitable units for use in measuring the output of B eliminators. In any event, the voltage cannot be at all accurately read if one of the cheaper low-resistance type of meter is used.

A numerical example might make more evident the errors which will be introduced in the reading, if the incorrect type of voltmeter is used. As an example, suppose that we desire to measure the output voltage of a Raytheon B line supply device such as was described in the December, 1925, RADIO BROADCAST. If the receiver was drawing from the eliminator 20 milliamperes, the output voltage would be about 120 volts. However, if this output was measured with a low resistance meter, itself drawing about 20 milliamperes, the voltage read would be 75, an actual error of 38 per cent. However, if a high-resistance meter is used, such as is described on Laboratory Sheet No. 27, only about 2 milliamperes will be required by the voltmeter, and then the voltage read would be practically the same as the actual voltage, and a truer indication of the voltage being supplied to the set would be obtained.

The care which is necessary in measuring the output voltages of B line supply devices is not necessary in measuring B batteries, since a drain of 20 or 30 milliamperes will make very little change in the voltage of a B battery. Therefore, it becomes possible to read the voltages of these units with an ordinary voltmeter whether it have a low resistance or not.

No. 31 RADIO BROADCAST Laboratory Information Sheet September, 1926

Distortion in Receivers

SOURCES AND REMEDIES

THERE are several points in a receiver where distortion can occur. In the first place, if the radio-frequency amplifier or detector circuits are tuned too sharply, distortion will occur due to the fact that the side bands of the radio frequency waves which carry the voice or music will not be equally transmitted by the tuned circuit, and in this way unequal amplification is obtained.

If a grid leak and condenser system of detection is used, it is not at all impossible to overload the detector tube on strong local stations. If this occurs, the various frequencies will not be properly amplified by the detector tube and serious distortion will occur. For real quality on local stations, a C battery detector is advisable since it can handle comparatively larger amounts of signal strength without overloading.

Distortion can occur in the audio frequency amplifier. To prevent this, good transformers should be employed, if this form of coupling is used, and a C-battery bias should always be placed on the grids of all the audio amplifiers in order to prevent the tubes from overloading. If overloading does occur, the peaks of the voice waves will be cut off, and serious distortion results. Also, if the wiring of the audio amplifier is rather poorly done, it is not at all impossible that the audio amplifier will begin to oscillate, sometimes at inaudible frequencies and sometimes at audible frequencies. If the oscillation is audible it can be fairly easily checked up and corrected, but if it is inaudible, it is sometimes quite a while before we realize just what the trouble is. The only practical method that can be used to detect these inaudible oscillations, is to place a milliammeter in the plate circuit of the tube of the suspected circuit. After putting this meter in the plate circuit, the input to the tube is short-circuited (if a transformer-coupled amplifier is used, a lead would be connected between the G post and the F post on the transformer) and no change should take place in the reading of the plate milliammeter. If a change in the reading does occur, it is a fairly good indication that the circuit is oscillating. Of course, during this test, no signals whatsoever should be received.

The final point at which distortion might occur is in the reproducing device. In order to obtain best reproduction from a cone speaker, it is necessary to use a semi-power tube in the output stage, with sufficient voltage to prevent overloading. It is also essential that the impedance of the loud speaker be fairly closely matched with the plate impedance of the output tube. If any discrepancy between the two impedances does exist, the tube should be preferably of a lower impedance than the speaker.

No. 32 RADIO BROADCAST Laboratory Information Sheet September, 1926

Matching Tube and Loud Speaker Impedances

THE USE OF AN OUTPUT TRANSFORMER

MANY recent articles dealing with quality amplification have stressed the point that an endeavor should be made to approximately match the impedance of the output tube with the impedance of the loud speaker. This fact is important from two standpoints; first, from the standpoint of quality and, secondly, from the standpoint of efficiency.

Regarding the first point, if a low-impedance cone speaker is used with a high-impedance tube, such as the 201-A, the low frequencies will be lost and undue prominence will be given to the high frequencies. In order to eliminate this drawback, and at the same time make it possible to obtain a considerably greater amount of undistorted power, the new type 112 and 171 tubes have been developed; both of these have quite a low plate impedance. The characteristics of these two tubes were printed on Laboratory Sheets Nos. 7 and 12 respectively. By the use of such tubes, the frequency distortion (produced when a high-impedance output tube is used) is practically eliminated.

When we use a low-impedance tube and thereby better the quality output of our receiver, we at the same time increase the efficiency with which the power developed by the tube is delivered to the loud speaker. Maximum power will be delivered to the output when its impedance is equal to the tube impedance, so that, for best results, the loud speaker impedance at a medium frequency, say 1000 cycles, should match fairly well the output impedance of the tube.

A simple method whereby tubes and loud speakers of different impedances may be used together, is by the inclusion in the circuit of a suitable output transformer, several of which are now on the market. When this plan is resorted to, it is necessary for the impedance of the transformer primary to approximately match that of the tube. The secondary should have an impedance similar to that of the loud speaker. In this way, it becomes possible to use a low-impedance speaker with a high-impedance tube, although it is not particularly advisable since the high-impedance tubes are not capable of handling any great amount of power and will very likely overload, if they are used to supply a loud speaker.

If a semi-power tube is used in the output, it is not generally advisable to connect the loud speaker directly into the plate circuit of the tube since, if this is done, the d. c. plate current will pass through the loud speaker windings and will harm the magnets used in the loud-speaker unit. In order to eliminate the d. c. from the loud speaker windings, either an output transformer or a combination of a choke and condenser should be used.

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

Contributions to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prize winner for the last period is announced in the August Radio Broadcast. *Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* Radio Broadcast, *Garden City, New York.*

A New Primary for the Browning-Drake R. F. Transformer

On account of its extraordinarily high efficiency, the Browning-Drake circuit has won much favor with radio fans; especially since the construction of this type of set is simple and straightforward.

The only difficulty I came across when building the coils for my first receiver of this kind was in the construction of the former for the primary of the r. f. transformer. This primary is wound in a narrow groove, and a turned form made of wood or hard rubber is generally specified.

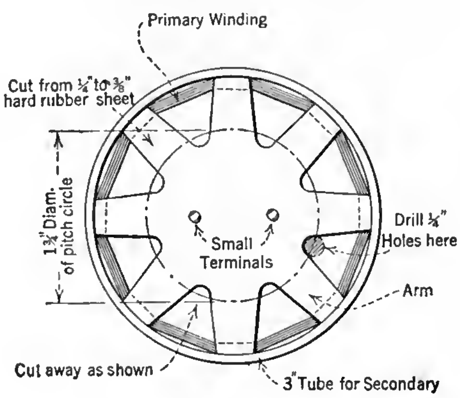


FIG. 1

Having no lathe, I made some experimental forms consisting of three cardboard discs. Two of these were cut just large enough to go into the coil former with slight pressure, the third was about 5/16" less in diameter. The three discs were cemented together with their centers coinciding. Quite a useful form was the result, but for the finished set, something better was desired.

Having some small pieces of 5/16" hard rubber in my junk box I set to work and finally evolved the new low loss form shown in the accompanying sketches Figs. 1, 2, and 3. It is merely a star-shaped pattern with eight arms. The top ends of the arms are slotted to take the primary winding (as shown in Fig. 1.)

The tube used as a form for the secondary winding had an outer diameter of three inches; the form for the primary was filed and sandpapered down until the arms made a good fit within the outer, larger, tube.

To mark out this form, paste a piece of drawing paper over the piece of hard rubber selected. Draw the center lines, and divide each ninety-degree section formed by these center lines into four equal parts, as indicated in Fig. 2. Next draw the pitch circle for the 1/4" diameter holes, and mark the holes with a center punch. Drill these holes before proceeding with the marking.

Draw the outer circle X in Fig. 2, with a diameter equivalent to the inside diameter of the cylindrical tube and mark the width of the arms on this circle. This width may be about 3/8". From the points A and B, draw tangents to the small holes drilled previously.

Using a sharp new hacksaw blade, cut out the form along the lines marked. Some care must be exercised during this operation or the hard rubber sheet may split. The cutting is made much easier if the sheet is clamped in a vise.

The sheet of paper which had been pasted to the hard rubber sheet is now washed off with warm water and the coil form is throughly dried. Finish it by rubbing it all over with a little machine oil and polishing it with the finest sandpaper you can lay your hands on.

It only remains to slot the arms of the form for the primary winding. Again it is clamped in the vise, with the top of the arm just projecting. To prevent it being marked by the jaws of the vise, place a thin smooth board on each side of the hard rubber form before clamping it.

The slot should be about 1/16" wide. A

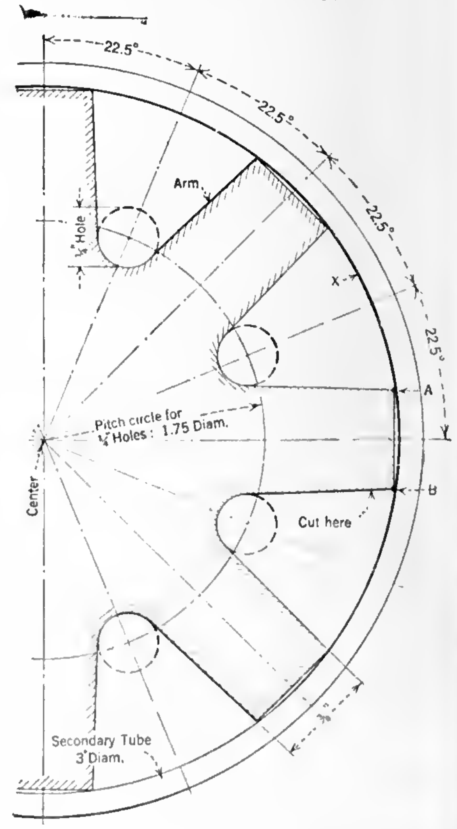


FIG. 2

The New Balkite Charger

MODEL J has two charging rates. A low trickle charge rate and a high rate for rapid charging. Can thus be used either as a trickle or as a high rate charger. Noiseless. Large water capacity. Rates: with 6-volt battery, 2.5 and .5 amperes: with 4-volt battery, .8 and .2 amperes. Special model for 25-40 cycles. Price $19.50. West of Rockies $20.

Balkite Trickle Charger

MODEL K. With 6-volt "A" batteries can be left on continuous or trickle charge thus automatically keeping the battery at full power. With 4-volt batteries can be used as an intermittent charger. Or as a trickle charger if a resistance is added. Charging rate about .5 amperes. Over 200,000 in use. Price $10. West of Rockies $10.50.

A New Balkite "B" at $27.50

Balkite "B" eliminates "B" batteries and supplies "B" current from the light socket. Noiseless. Permanent. Employs no tubes and requires no replacements. Three new models. Balkite "B"-W at $27.50 for sets of 5 tubes or less requiring 67 to 90 volts. Balkite "B"-X for sets of 8 tubes or less; capacity 30 milliamperes at 135 volts—$42. Balkite "B"-Y, for any radio set; capacity 40 milliamperes at 150 volts —$69.

Balkite Combination

When connected to your "A" battery supplies automatic power to both "A" and "B" circuits. Controlled by the filament switch on your set. Entirely automatic in operation. Can be put either near the set or in a remote location. Will serve any set now using either 4 or 6-volt "A" batteries and requiring not more than 30 milliamperes at 135 volts of "B" current—practically all sets of up to 8 tubes. Price $59.50.

All Balkite Radio Power units operate from 110-120 volt AC current with models for both 60 and 50 cycles. Prices are higher in Canada.

Announcing the new
Balkite Light Socket Radio Power Units

A new Balkite Charger with both trickle and high charging rates. Three new Balkite "B's" including the new popular priced Balkite "B"-W at $27.50. The new Balkite Combination—with the "A" battery it furnishes automatic power to both circuits.

Now you can operate your radio set from the light socket. Merely by adding the new Balkite Radio Power Units—either by adding a Balkite Charger and Balkite "B," or by adding the new Balkite Combination Radio Power Unit.

In either case the result is the same—light socket operation, maximum convenience, and smooth silent power.

Balkite Light Socket Power is noiseless. There is no hum. It is never low and never runs down, but is always exactly what is required by the set. It is permanent. Balkite Radio Power Units are permanent pieces of equipment. They employ no bulbs, and have nothing to replace or renew. They cannot deteriorate from either use or disuse. Other than a negligible amount of household current their first cost is the last. With sets of high current requirements their use is highly desirable for the saving alone. They require no changes in your set.

Over 600,000 radio receivers—one of every ten—are already Balkite equipped. Equip yours with Balkite and convert it into a light socket receiver. Know the pleasure of owning a set always ready to operate at full power.

FANSTEEL
Balkite ★
Radio Power Units

Manufactured by FANSTEEL PRODUCTS COMPANY, INC., NORTH CHICAGO, ILLINOIS

Sole Licensees in the United Kingdom: Messrs. Radio Accessories Ltd., 9-13 Hythe Rd., Willesden, London, N. W. 10

fine hacksaw blade will cut a slot of just this width. The depth of the slot will have to be $\frac{3}{16}''$, or more, according to the gauge of wire used for the primary winding.

To take the ends of this winding, fit two small terminals near the center of the form. I say small intentionally, for even slight amounts of metal within the field of a coil tend to reduce its efficiency. These terminals are very convenient, since connections to the bus bar leads can now be made with short lengths of flexible wire, and the primary can be removed without having to undo a soldered joint.

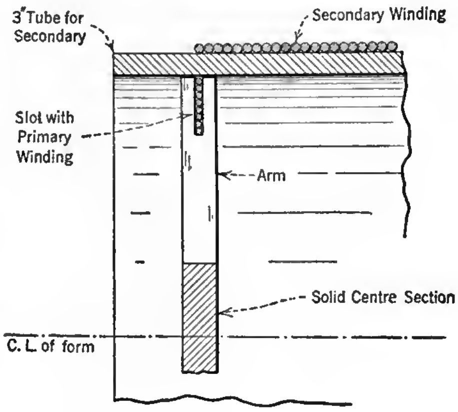


FIG. 3

The form is wound as usual, the greater part of the wire lying exposed between the arms, and therefore we are justified in calling the coil a low loss one.

So far as efficiency is concerned, it will be found that a coil made in this manner compares very favorably with coils made to the standard design. A form of this type is really far more difficult to describe than to make, the one shown in the illustrations being made and wound completely in less than two hours.

C. A. Oldroyd,
Barrow-in-Furness, England.

A Rheostat Sub-Panel for the Roberts Receiver

A SIMPLE method of eliminating the rheostat knobs from the panel front on the Roberts receiver, is shown in the accompanying Fig. 4. It consists of a sub-panel, SP, about 2 x $4\frac{3}{4}$ inches, on which are mounted the

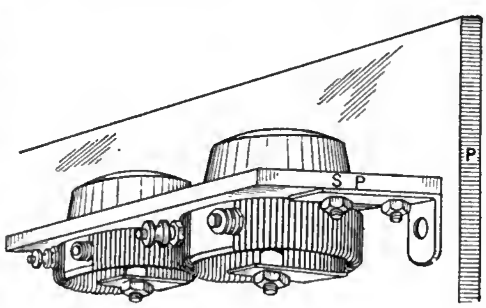


FIG. 4

rheostats. On this sub-panel are bolted two small brass angles, one at each end. In order to avoid bolt heads showing on front of the panel P, a small hole should be drilled almost through the panel from behind and tapped for a short bolt. Then the sub-panel is screwed to the panel. If a brace is used for the panel, one of the bolts can be so arranged that it will answer for both the brace and angle. It is well to keep the unit high on the panel, allowing just enough room for the rheostat knobs to clear the cabinet easily.

This unit will fit perfectly over the antenna and secondary coils in the Roberts receiver. For a slanting panel it is advisable to bend the angles so that the sub-panel is parallel to the base board. The unit allows easy adjustment of rheostats, and makes possible the simplification of the panel on any set where the rheostat adjustment, once determined, has little or no effect on the operation of the set.

L. D. Sauer,
Dayton, Ohio.

A Simplified Battery Throw-Over Switch

THE layout in Fig. 5 permits, by a simple twist of the wrist, as it were, the connection of the storage battery to the set or to the charger, as may be desired. The old "clip and plug" process has been discarded, and in its stead a double-pole double-throw switch, with permanent wiring, has been substituted. This hook-up can be used for panel or wall mounting, or may be used inside a radio table or cabinet.

This, I believe, to be an improvement over the hook-up contained in the April RADIO BROADCAST inasmuch as a two-blade knife switch is substituted for the three-blade switch; furthermore, the necessity for the extra long contact connecting the charger to the line supply (which type of

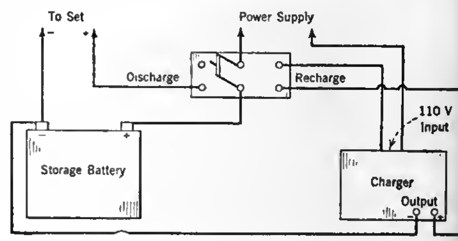


FIG. 5

throw-over switch must be specially constructed), is eliminated.

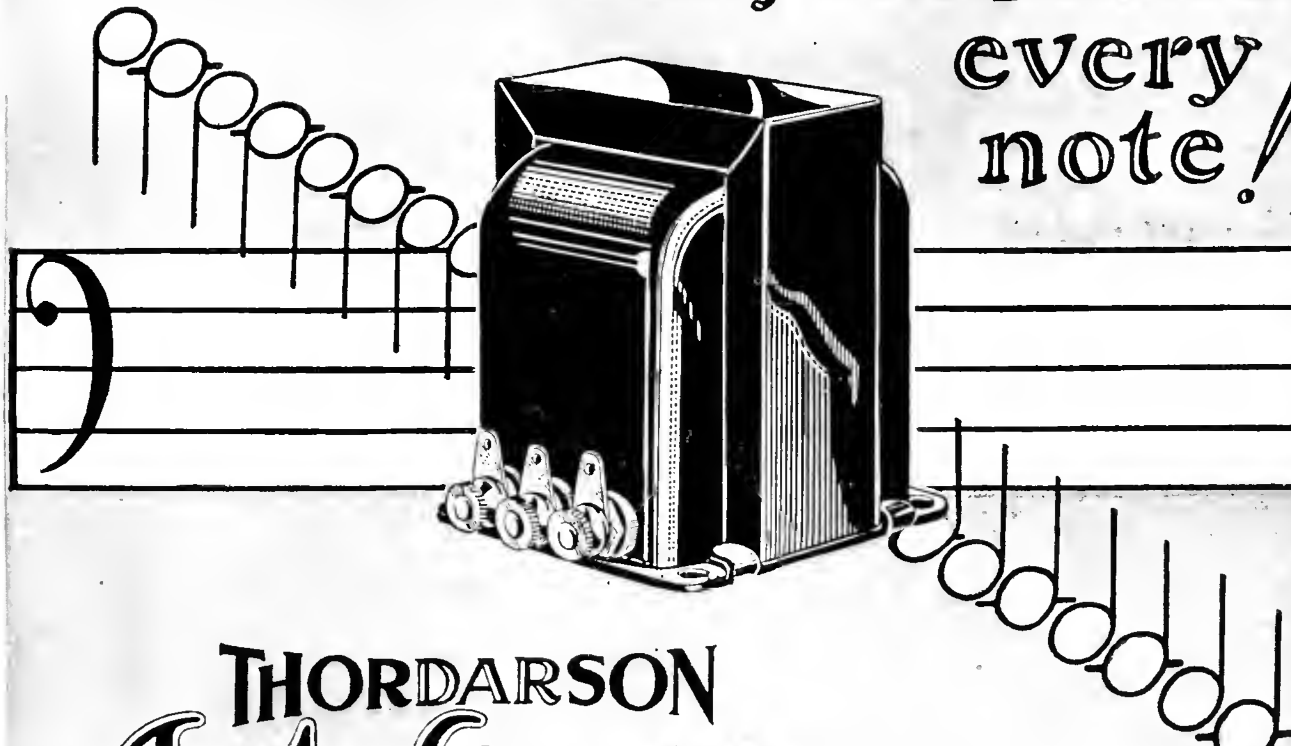
H. R. Nichol,
Washington, District of Columbia.

A Precaution to Prevent Tube Burn-Outs

FIVE perfectly good vacuum tubes had burned out and the owner was afraid to put any more in for fear that they would go too. Here is what the service man found when he came to look at the installation. Acid had at one time been spilled on the 90-volt cable and had eaten away all of the insulation. This bare wire had apparently bumped up against the negative pole of the storage battery. The negative B lead being connected with the positive of the A battery, the full 90 volts were placed directly across the tube filaments, thus burning them out. The lesson to be learned from this is that one cannot be too careful in keeping the storage battery free from excess acid and also to keep the wires well separated at all times. If separate compartments cannot be had for the two batteries, it is always best to fasten the various wires with staples so that they cannot possibly be mixed up and cause damage.

K. B. Humphrey,
Brooklyn, New York.

Fully Amplifies every note!



THORDARSON Autoformer

Step-up Impedance Coupled Amplifier

Full Amplification of Bass Notes

Greater Clarity on all Programs

Improved Reception of Weaker Stations

Better Volume Control

Impedance coupling is universally accepted as the most perfect form of amplification from a reproductive standpoint—But the amplification increase of the straight impedance is low.

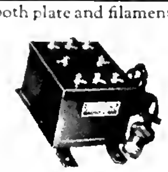
The Thordarson Autoformer is an impedance with a step-up ratio—It combines the faithful reproduction of the impedance with the amplification increase of the transformer, paving the way for the release of the deeper tones with increased volume and unrestrained quality.

Price each *$5.00*

Note: Only Thordarson makes the Autoformer

POWER From the A. C. Line

Power Amplifier Supply Transformer, R-198 furnishes current for both plate and filament of the power stage using the U. X. 210 power tube with 400 volts on the plate and 7½ volts on the filament. In addition furnishes complete B-supply for the set.



Price.......$12.00

B-Eliminator Transformer R-195 is designed for use with the Raytheon tube, furnishing B voltages for the entire receiver. Capable of supplying 140 volts at 40 milliamperes. Conservatively rated. Will not heat up in continuous service.

Price $7.00

30 Henry Choke Coil R-196 is used in the filter circuits of power amplifiers and B-eliminators operating from the house lighting current. D. C. resistance 280 ohms. Capacity 70 milliamperes.

Price $5.00

★

THORDARSON ELECTRIC MANUFACTURING CO.

Transformer specialists since 1895

WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS

Chicago, U.S.A.

LETTERS FROM READERS

Contributions from Readers on Various Subjects of Radio Interest—An Open Forum for All

Broadcasting Stations in Argentina

HERE is a list of broadcasting stations now operating in Argentina, which we print—as far as our America-resident readers are concerned—rather as a record than an exhortation to be "up and doing," so to speak.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Herewith a list of broadcasting stations now in operation in Argentina. This list makes obsolete yours which appeared in the February RADIO BROADCAST.

LOCATION	CALL	WAVE-LENGTH	POWER IN WATTS
Buenos Aires	LOO	250	——
Buenos Aires	LOQ	260.8	500
Buenos Aires	LOR	400	1000
Buenos Aires	LOS	285.7	5000
Buenos Aires	LOT	272.2	1000
Buenos Aires	LOV	352.9	1000
Buenos Aires	LOW	300	1000
Buenos Aires	LOX	375	500
Buenos Aires	LOY	315.8	1000
Buenos Aires	LOZ	333.3	1000
Buenos Aires	B2	275 & 214.8	100
San Fernando	D3	235.3	100
La Plata	LOP	425	1000
Santa Fé	F1	275	20
Rosario	F2	270	100
Rosario	F3	265	100
Rosario	F4	260	100
Rio Cuarto	H5	275	100
Cordoba	H6	250	20
Cordoba	H7	320	100
Villa Maria	H8	296.4	250
Cordoba	H9	381.1	100
Mendoza	LOU	380	500

There are also two small stations in Mendoza. but I have no details to hand of these.

Trusting this material may be of use to you in correcting your lists,

Very truly yours,
C. E. SMITH,
La Calera, Argentina.

That Spark Interference

AN INQUIRY from RADIO BROADCAST to the Independent Wireless Telegraph Company concerning spark interference, brings the following self-explanatory letter. There are three sides to the question, those of listener, interference producer, and apparatus manufacturer. We have not investigated the latter but, judging from the letter herewith, it is apparent that the Independent should not be condemned without due consideration of the hardships under which they apparently labor.

SIR:

I am in receipt of your letter of the first instant advising that the general tendency in the operation of ship-shore service has been to convert the transmitter to continuous-wave operation as rapidly as it was financially and technically feasible, and in which you called our attention to the fact that our station at East Hampton, Long Island, continues to use a spark transmitter We are thoroughly in accord with the change over from spark transmitters to continuous-wave transmitters, and we have spent a large sum of money in changing over same at our East Moriches (WSH) Station. We have also directed about 90 per cent. of our traffic via the continuous-wave station at East Moriches.

Unfortunately at East Hampton we have been unable to obtain a suitable continuous-wave transmitter for short waves at what we figure to be a reasonable price. In taking the matter up with the manufacturers, the price quoted us was considered excessive, in that, in addition to the usual purchase price, which we learned was greater than that charged to others, we were required to pay a 10 per cent. royalty on gross receipts for five years. In other words, after having made a payment in excess of the usual price for the apparatus, we still had to pay 10 per cent. of the gross receipts for five years. This would mean a loss in operation during some of the periods when traffic is light.

The question of the price of the equipment has again been taken up with the manufacturers, and we hope to be able to reach some agreement. If a satisfactory arrangement can be made with the manufacturers, we plan to use the East Hampton Station as a purely receiving station and place all of the transmitting gear at East Moriches, operating same by remote control.

We fully appreciate and sympathize with the broadcast listeners who are more or less affected when the East Hampton transmitter is being operated, but unfortunately we are unable to clear this interference until a satisfactory arrangement can be made with the manufacturers of the short-wave continuous-wave apparatus.

Very truly yours,
C. J. PANNILL,
Vice-President,
Independent Wireless Telegraph Company.

In Which We Permit a Gentle Pat on the Back

GRACIOUS reader, you are now deigning to read the last column of text in the September RADIO BROADCAST. If you have enjoyed our program, won't you please drop us a line and . . . we'll, maybe we shall reconsider that paragraph under the "Help Wanted" in this morning's *Times*, for, after the above, we must assuredly qualify for that position open for man with ability to say the right thing at the right time, etc. Nevertheless, we must admit that we rather like receiving letters such as that printed below from Doctor Baetz, Californian.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Your June number of RADIO BROADCAST has just arrived on the Coast and is making a great hit with its Silver-Marshall-Six improvements. The usual radio publication has done a great deal of harm by boosting a new circuit every month and dropping it "for better or worse" in favor of the next advertiser.

I thank you very much for your recent letter of information concerning radio troubles. It is the first useful information I have been able to obtain. I had previously applied for information at the manufacturers and a number of radio magazines to which I subscribe. All previous answers were written by clerks who knew less about radio than I do.

Thanking you for your courtesy and help,

Yours very truly,
WALTER G. BAETZ, M. D.,
Huntington Park, California.

Who Invented the Microphone?

How the Prototype of the Modern Broadcasting Microphone Was Evolved After Six Weeks Experiment—From Crude Equipment

By CLARA LOUISE LESLIE

THE heart of radio broadcasting is the microphone—that little instrument which has become the world's mouthpiece; yet little is heard of its origin. It is the purpose of this short story to place before the reader the interesting facts relative to the discovery of the microphone principle, which dates back almost half a century. In keeping with the important rôle it was destined to play, the microphone was no casual discovery; nor was its launching among the world of inventions an uneventful experience.

EMILE BERLINER
He is here shown examining an up-to-date example of his own inventive genius, the microphone at WRC, Washington

At the time of its issue, the microphone patent was the most commercially valuable patent ever issued, and, as may be supposed, the story surrounding the birth of this "adjunct to civilization" is not without its romance.

The microphone was invented in 1877, and the man who lays claim to the unique title of "Father of the Microphone" is Emile Berliner.

Berliner was born in Hanover, Germany, and immigrated alone to the United States when only 19 years of age. He had been living in this country only about long enough to master the English language when he became engrossed in the subject of science, particularly electrical science, which began to sweep over public thought at that time. It is just half a century ago that the public mind became electrified seemingly all at once, to the thought of strange new possibilities.

It was to Washington, District of Columbia, that young Berliner had gone to make of himself "a good American." He clerked in a dry goods store in the day time, and during the nights he pondered these great new subjects alone in his little "third floor back." He was poor, and had been equipped with nothing but a public-school education.

A great man was once asked how he accomplished a certain great achievement. His reply was, "By always thinking about it." This, without question, was the system Berliner used. He dug up scientific secrets out of that mine of inner logic. He had heard rumors of Bell's telephone but it was not yet in public use, and he had never seen one; and it is remarkable that within six weeks from the time Berliner had bought his first equipment and begun to experiment with his tin can telephones and soap box transmitters, that he brought to light the microphonic principle that has never been changed nor superseded.

The first microphone consisted of a portion of a toy drum. The head of the drum constituted the diaphragm, and the delicate loose contact—a startling innovation in electrical science up to that time—was made by a steel dress button hanging by a fine bit of metal embroidery thread so that it just touched the point of a steel sewing needle which had been projected through the drum head from the back. Berliner used this arrangement on March 4, 1877. This contact, when attached to a battery, was found to act both as a transmitter and receiver. Berliner thus had a telephone system of his own, and it resembled Bell's magneto system only in that it employed the basic undulatory current.

The original Bell instrument was a magneto telephone. Berliner was the first to introduce a battery current transmitter and also an induction coil or transformer into a telephone circuit. He obtained a patent for the latter on January 15th, 1878. The induction coil, or transformer, is, in radio, the connecting link between the telephone circuit and the ether current, and is, of course, one of the real essentials in broadcasting.

But the idea of the loose contact, which principle is the basis of all microphonic action, came to Berliner in a flash of inspiration. He had been experimenting for a short time with the meager equipment in his improvised bedroom-laboratory when, one day, he was talking to a friend of his in charge at a telegraph station near by.

BERLINER'S FIRST MICROPHONE
Of March 4, 1877. That illustrated is a replica made by him in 1879

Order your copy of *Radio Broadcast* from your news dealer or radio store. Make sure that he reserves a copy for you each month. If your favorite radio store does not stock the magazine write us giving name of radio dealer and address.

★ Tested and approved by RADIO BROADCAST ★

"Do you mean that more current goes over the wire when I make a firm contact?" Berliner asked, as they stood conversing over a Morse key. Being answered in the affirmative, Berliner sped back to his lodging house as one under a spell. He knew he had mentally solved the problem. That cold spring night he rigged up the toy drum and it responded! That constituted the birth of the microphone.

LEGAL STRIFE PRECEDES PATENT RECOGNIZATION

IN BERLINER'S office to-day is a replica of that first microphone, and over it one can plainly hear even the ticking of a watch.

About a year after the invention was made it was found that it was the combination of Berliner's microphone transmitter with Bell's magneto receiver that made the perfect telephone circuit as we have known it ever since. Radio is, of course, an extension of telephony.

Then, the microphone patent, applied for by Berliner on June 4, 1877, was destined to play the star rôle in one of the greatest patent dramas ever staged. It became tangled up in patent interference which lasted more than fourteen years and during which time all kinds of accusations were aimed at it in an endeavor to declare someone else the prior inventor. However, Berliner's application was finally recogni-ed by the Patent Office on November 17th, 1891. Being controlled, as it was, by the Bell Telephone Company, the issuance extended the life of the Bell monopoly for another seventeen years. Immediately following the day the patent came out, the newspapers from Maine to California were flooded with comment on the subject. The following is taken from the Boston *Globe* of November 18th, 1891:

> The Berliner patent, issued this morning from the patent office at Washington, is, next to the original Bell patent, the most important patent in the telephone field ever issued. It covers every known form of battery transmitter, and underlies the Blake transmitter, the mechanical device in use in the ordinary box transmitter, and the Hunning transmitter, the mechanical device behind the mouthpiece of the ordinary "long-distance" transmitter. The Blake transmitter uses two single points of variable contact in the transmission of speech. The "long distance" transmitter uses a multiplicity of carbon points of variable contact, but the Berliner patent just issued covers the principle of any variable contact used in the transmission of the sounds of the human voice. All forms of the microphone, of carbon, or any other contact in use for magnifying sound, the "hear-a-fly walk" device, an amusing illustration of the wonderful powers of the microphone which entertained many people about 10 years ago—all these and all succeeding mechanical devices, built upon the variable contact principle, now come under the Berliner patent, which bears date to-day, and can be protected from infringement for the next 17 years. . . . No known device can be practically used in the telephone exchange system, or in the transmission of speech over long distances except by the Berliner principle of a variable point of contact.

The *Electrical World*, of November 18th, 1891, made the following statement:

> Rarely has a patent on any subject whatever caused so profound a sensation as has the granting to Emile Berliner, on November 17, of what on its face appeared to be a broad claim on the microphone transmitter now used well nigh universally wherever the telephone exists. Electrical circles were less surprised than the general public, but a feeling akin to consternation has pervaded the atmosphere during the past week. It is indeed an extraordinary patent, no less on account of the sweeping character of some of its claims than by reason of its remarkable history in the Patent Office. For an application to remain for one cause or another locked up in the

(*Continued on sixth page following*)

The Pacent Powerformer is only 8 x 8 x 10 inches and its weight is approximately 32 pounds, making it truly portable. The Pacent Cone is made in two sizes, 17 inches in diameter and 3 feet in diameter.

A new day has dawned in radio with the arrival of the Pacent Powerformer and Cone

IT is no exaggeration to say that, with the development of the Powerformer by a group of engineers, under the direction of Louis Gerard Pacent, a new day has dawned in radio.

The Pacent Powerformer reproduces music and speech with a tonal quality and range that defy description, the volume ranging from a whisper to a roar. It also eliminates B Batteries.

List Price, exclusive of tubes but including all necessary connections $82.50.

The Pacent Cone Speaker (illustrated above) is manufactured under the Lektophone patents. The supremacy of the cone type of speaker over all others is now generally recognized. the supremacy of the Pacent Cone is due not only to its practically unlimited tone range, but to the volume and faithfulness which gives full rich tones with delicacy and without distortion.

PACENT CONE, Type A, 17 inch, Bronze base . . $28.50
West of the Rockies $31.50

PACENT SUPER-CONE, Type, SA, 3 feet in diameter, mounted on walnut stand $79.50
Slightly higher West of the Rockies

PACENT SUPER-CONE, Type WA, Similar to Type SA, but arranged for hanging on wall . . . $65.00
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All types are equipped with a suitable length cord and Pacent Detachable Plug

Each of these new Pacent developments must be heard to be appreciated and the absolute revolutionary quality of reproduction realized.

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IN PLANNING what you are to handle this coming season, you hope, of course, for none of the grief which has accompanied many receivers in the past, and the Browning-Drake sound merchandising principles, in marketing a product of undisputed excellence, we believe, will be interesting to you.

The research at the Cruft Laboratory of Harvard University, begun in the summer of 1923 by Glenn H. Browning and Frederick H. Drake, has set the mathematical standard of design for radio frequency transformers, and is universally recognized as the scientific authority on this most important subject, justly called the "heart of any circuit."

One stage of scientifically designed radio frequency, incorporating the Browning-Drake transformer, together with the flexibility of a two control receiver, has yet to be improved upon for all around satisfactory reception. Our research facilities are such that minor refinements are constantly being made without the necessity of yearly models to upset the industry.

Producing one model fairly priced, with reasonable dealer discount, and distributed only by the highest grade jobbers, the Browning-Drake Receiver has never been cut, and no dealer has ever lost money on Browning-Drake. Your percentage of returned sets will be an absolute minimum, for your custumers have confidence in the Browning-Drake name and its standards, and know it represents a laboratory standard of development which will not be superseded or radically changed for many years.

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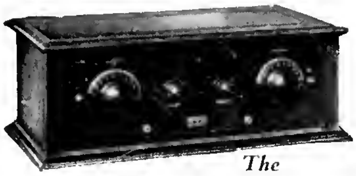
For further information address the Browning-Drake Corporation, Brighton Mass.



The
BROWNING-DRAKE FIVE

BROWNING-DRAKE

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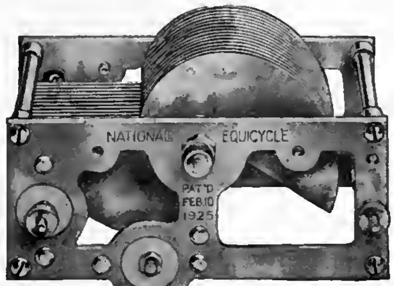
The Satisfaction of Successful Accomplishment

In one way or another, this is the basis of every man's interest in life.

No one tires of the satisfaction of a good job well done. You might hesitate to tackle alone the construction of a grand piano, with any expectation of getting a thrill out of it.

But with National Radio set essentials and the necessary additional parts and accessories, you can produce a modern, sensitive, selective, attractive and beautifully toned Radio set.

It will have every desirable quality that can be bought. It will have one quality which cannot be bought,—the thrill of successful self-accomplishment.



For Tuning

The NATIONAL "Equicycle" Condenser

True straight-line-frequency—but in three-quarters instead of a half-turn—spreading out crowded stations still more, rigid frame, plates—bearings smooth, yet without suspicion of end-play. Made to stand up, to log the same next year as this, and with the same high efficiency.

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Gives velvety, even movement of condenser shaft with *variable* reduction ratio of from 6-1 to 20-1. Large, easily operated knob without *any* back-lash—clear yet mathematically accurate dial with simple logging guide—heavy, lasting Bakelite case; easy to mount and gives precise and fine tuning on any set.

For Audio-Frequency Amplification

The NATIONAL Impedaformers, Type B

Three to a set—making possible, in the compactest form, true and faithful audio-amplification, from notes too low to be reproduced in phones or cone, to shrillnesses out of reach of our mortal ears. Each Impedaformer cases a high-inductance choke—a .1 Mfd. TOBE Coupling Condenser—a Lynch grid-leak—and the first one an R. F. choke, without which impedance-amplification is like meat without salt.

For Radio-Frequency Amplification

The Genuine NATIONAL Browning-Drake Radio-Frequency Transformers

With their scientifically computed coil-constants—product of research of G. H. Browning and F. H. Drake at Harvard University. Their theoretically correct space-wound enamel wire coils withstand rough handling; without alteration of characteristics—yet tests show lowest R. F. resistance recorded for coils of this type. Their simple supports make them units with their "Equicycle" Condensers, yet hold them far enough away to prevent absorption losses or increase their resistance.

These NATIONAL Radio-Set Essentials with the required sockets, panels, wire and accessories,—may be put together EASILY by you into a modern receiving-set:—Sensitive to distant signals, selective in its separation of closely-spaced stations, capable of lifelike, *faithful* reproduction,—simple to operate.

See our Exhibit at New Madison Square Garden, New York, September 13-18; and the Coliseum, Chicago, October 11-17

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INCORPORATED

Patent Infringement Notice

Pursuant to an Order of The Third Judicial District Court, in and for Salt Lake County, State of Utah, duly made and entered on the 25th day of June, 1926, in the matter of the Receivership of Nathaniel Baldwin Incorporated, the undersigned Receiver of said Company hereby serves notice on manufacturers, jobbers, dealers and purchasers of Radio Products that said Nathaniel Baldwin, Incorporated is the owner of United States Patents, Number 957403 dated May 10th, 1910, Number 1,153,593, dated September 14th, 1915, and Number 1,581,155 dated April 20th, 1926, all of which are duly recorded in the United States Patent Office at Washington, D. C. and that all persons manufacturing, jobbing, dealing in or purchasing Radio Products that are infringements on the aforesaid patents will be held liable for damages to the said Nathaniel Baldwin Incorporated.

Notice is also given that no rights of any kind or description are held by any Corporation, Company, person or persons to manufacture Radio Products under the aforesaid Patents.

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John K. Hardy
Vice President

Salt Lake City, Utah.

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World Batteries are nationally known for dependable, long wearing performance. Solid Rubber Case prevents acid and leakage.

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Just state battery wanted and we will ship same day order is received, by Express C.O.D. subject to examination on arrival. 5% discount for cash in foll with order. Send your order *now* and get your World Batteries at actual manufacturing cost.

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Solid Rubber Case Radio Batteries
6-Volt, 100-Amperes $10.50
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8-Volt, 13-Plate $12.50
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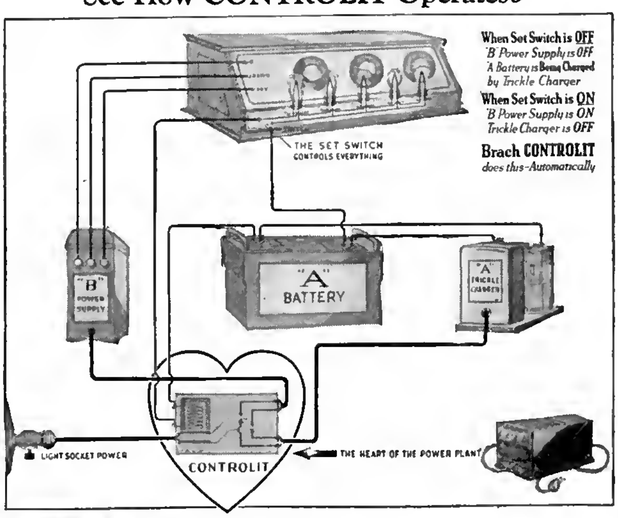
THE HEART OF THE POWER PLANT

Your set switch or rheostat ALONE can now control "B" Battery Substitute and "A" Trickle Charger automatically.

Merely adding a BRACH CONTROLIT makes any set a light power-operated set, eliminating all switches from "B" Battery Substitute and Trickle Charger. No added wiring. No alterations to set required.

Anyone can install CONTROLIT, and the power plant can be placed anywhere—in cellar, or closet, or shelf. No radio user will be without it. *Ask Your Dealer.* **Price Only $6 In U.S.A.**

See How CONTROLIT Operates



Brach ★ Radio Products

L. S. BRACH MFG. CO., Newark, N. J.
Makers of Famous Brach Lightning Arresters

Patent Office for $14\frac{1}{2}$ years before its issue, is almost unique.

Not until about three years later, when this famous Berliner patent had, through strategy, been summoned before the Supreme Court of the United States, was Emile Berliner finally granted unreservedly by every legal means of investigation that could be summoned, his just claim to the distinction of being the inventor of the microphone.

Berliner to-day, is still living in Washington, and still inventing. His inventions have always been related to the science of acoustics. His lateral cut disc talking machine record and principle of making innumerable duplicates of it, are as fundamental to the talking machine industry to-day as are his gifts of the microphone and transformer to telephony and radio.

It remains to be seen what Berliner's latest invention will do; early this year he was granted a patent for "acoustic tiles" and "acoustic cells." They are for the purpose of rendering perfect acoustics in all large buildings used for auditorium purposes. "The problem of hall acoustics has always been a guess by architects," Berliner explains. He claims that his latest invention solves the problem.

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the eleventh installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the August Radio Broadcast, *and will be reprinted in an early number.*

R113.5 Meteorological. Storms.
Radio. June, 1926, pp. 8–11. *Effects of,*
"Bending of Radio Waves by Storms," J. J. O'Neill.

Storms are said to act as reflectors and refractors of radio waves in the same way that a lens or a prism bends or refracts light rays. A storm is composed of atmospheric gases in various degrees of ionization. The effect of electrostatic and magnetic fields of force of radio waves is not unlike the effect of magnetic fields on light waves. Hig and low pressure areas and their effects upon the electrical condition of the atmosphere, the magnetic field of the earth and the effect of ionization by the sun on the outer atmospheric layers, make it possible to account to some degree for the bending of radio waves when passing through such complex electrical structures.

Observations have shown that the course the waves follow from the transmitting station varies considerably from the normal path, and that the refracted wave of each station tends to describe an arc of a circle concentric with the center of the high pressure area, or parallel to the isobars in the anticyclone area. Diagrams show how this distortion of the waves may occur. Since storms have a vertical as well as a horizontal structure, it is likely that the radio waves, which have a circular vertical as well as a circular horizontal section, would be subject to distortion.

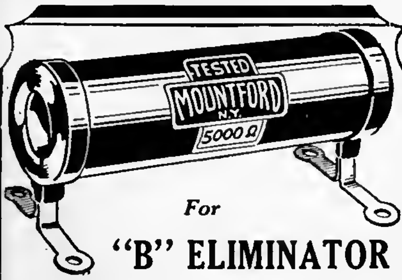
R138. Electron Emission; Ionization. Electron
Radio. June, 1926, pp. 12 ff. Emission.
"Why Do Radio Tubes Peter Out," V. G. Mathison.

The writer presents a simple explanation covering the structure of filament wires in vacuum tubes. Some of the late scientific discoveries about action of electrons emitted from various substances are told, and the problem of tube rejuvenation and the increasing of the active life of vacuum tubes is discussed.

R342. Amplifiers. Amplifiers.
QST. June, 1926, pp. 25–28.
"Amplifier Ins and Outs," C. T. Burke.

The question of good and poor amplifiers is considered for the audio stages. An audio transformer may be represented by an equivalent filter circuit (shown in Fig. 1), which will bypass a definite band of frequencies as desired —for broadcast 100 to 5000 cycles, for telegraphy 800 to 1200 cycles, approximately.

Transformers are compared by reproducing their amplification curves, using frequency as abscissae and amplification as ordinates. This the author has done for four widely different transformers. The effect of using low or high primary impedance, and low and high ratio of turns, is outlined in detail, illustrations supplying the necessary information. Shunting transformers with leaks or condensers usually is detrimental for most transformers, as shown by curves.



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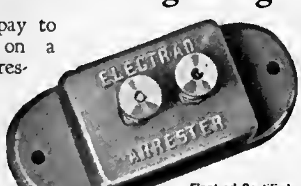

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R386. FILTERS. SUPER-HETERODYNE
Radia. June, 1926, pp. 22–24 BAND FILTER.
"Design of Band Pass Filters for Super-Heterodynes," R. B. Thorpe. (Cont'd from May issue, pp. 25)
A study of design factors for band pass filters used with super-heterodynes is discussed, and a table presented showing values of filter constants for definite cut-off frequencies. Formulas are given for determining the constants of the filter circuit, inductances, and capacities, for the cut-off frequencies desired.

R342.2. RESISTANCE COUPLING. COUPLING.
Radio. June, 1926, pp. 25–26. *Resistance and Impedance.*
"Improving the Resistance- or Impedance-Coupled Amplifier," C. Osborne.
The resistance- and impedance-coupled audio amplifier sometimes has r. f. currents bypassed, which results in howls and squeals being heard in the reproducing device. This is especially the case with super-heterodynes, where two a. c. components are found after the second detector tube. The r. f. component should be eliminated, which can be done by introducing an r. f. choke coil and a condenser next to the plate of the detector tube (shown in Figs. 1 and 2). The size of the choke will depend upon the type of r. f. amplification employed.

R343.5. HETERODYNE SETS. SUPER-HETERODYNE,
Radia. June, 1926, pp. 29–30. *Best's.*
"Improvements in the Best Super-Heterodyne," G. M. Best.
The writer presents four schematic wiring diagrams of the Best Super-Heterodyne with improvements in the design, previous articles having appeared in May, 1924, January, August, and September, 1925, showing this circuit layout.

R430. INTERFERENCE ELIMINATION. INTERFERENCE.
Radio. June, 1926, pp. 31–32.
"Radio Interference From Power Lines," P. S. Donnell.
The causes of radio interference and suggested remedies are listed as follows: Line troubles, insulator leaks, lightning arresters, transformers, generators, motors and synchronous converters, arc light circuits, smoke and dust precipitators, sign flashers, heating pads, violet ray machines, X-ray machines, mechanical rectifiers, electric elevators, electric furnaces.

R613. SHIP STATIONS. MARINE TUBE
Radio. June, 1926, pp. 33–34. TRANSMITTER.
"Modern Marine Radio Equipment," H. S. Pyle.
The text discusses in detail the four component parts of one of the modern shipboard radio telegraph stations: Transmitter type ET 3627–A using three UV-211 power tubes rated at 100 watts each; type 501 receiver; power plant, and auxiliary supply source.

R110. RADIO WAVES. POLARIZED
QST. June, 1926, pp. 9–16. TRANSMISSION.
"Polarized Transmission," R. S. Kruse.
In an interview with Doctor Alexanderson, Mr. Kruse points out some discrepancies between common knowledge gained from old text books regarding radiation, and information obtained through short-wave experiments. Our former conception of radiation was based on loaded antennas, fairly long waves, and ground connection or fairly high capacity counterpoise, he states. With the use of short waves, transmission and reception was reported very good using horizontal instead of vertical antennas. Alexanderson constructed a special horizontal loop tuned to 6000 kc. (50 meters) in order to study horizontally polarized waves. The various effects were observed with an exploring antenna (described) and a four-tube receiver reading comparative values in microvolts per meter. The composite picture which was obtained from the test was a continuously twisting plane of polarization with alternated points of plane and circular polarization. Therefore, a horizontal and a vertical wave component exist with different velocity of propagation, he says. When the horizontal and the vertical are in phase, they give plane polarization: when 90 degrees out of phase, they give circular polarization.
The mechanical model used to illustrate this phenomena is described, and its operation discussed. There seems to be no doubt that the currents induced in the ground play some part in the transmission of radio waves, as noted.

R344.3 TRANSMITTING SETS. TRANSMITTER,
QST. June, 1926, pp. 29–32. *Crystal-Controlled.*
"A Multi-Stage Crystal-Controlled Transmitter," J. M. Wells and E. D. Tillyer.
A three stage power-amplifier crystal-controlled transmitter is presented with detailed information on how to build and operate it. Either a 937 kc. (320-meter) or a 1874 kc. (160-meter) crystal may be used, depending upon the number of stages of amplification and the final working wave desired. Each successive stage is worked on the harmonic of the preceding one, thus unusually stable operation is obtained.
In building the set, each tube circuit should first be set up and adjusted separately before starting the next one. Beginning with an UX-112 oscillator and reduced plate voltage, this circuit contains the crystal. The output is then fed into another UX-112, and from there into an UX-210 tube. To this arrangement may be added either a 50-watter or a 250-watter. The method of tuning and making adjustments is given in detail.

R344.3. TRANSMITTING SETS. TRANSMITTER,
QST. June, 1926, pp. 45–48 1 XM.
"A. R. R. L. Standard Frequency Station 1 XM," K. V. R. Lansingh.
The experimental station located at the Massachusetts Institute of Technology, call 1 XM, is described. An 100-watt transmitter, consisting of two 50-watt tubes in a push-pull circuit of unusual design (shown in Fig. 4), is mounted on a vertical panel with tube rectifiers for plate voltage. A second transmitter, used for sending standard frequencies, uses a 250-watt tube in a tuned-plate, tuned-grid circuit (diagrams shown). The method of quickly adjusting this transmitter to the desired frequency is outlined. A power panel, similar in appearance to the transmitter panel, supplies power to both transmitters.

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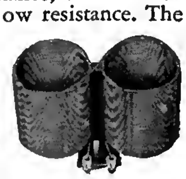

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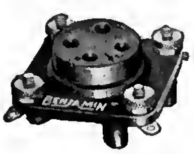

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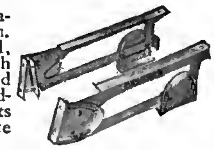

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R344.3. TRANSMITTING SETS. TRANSMITTER, *Crystal-Controlled.*
QST. May 1926, pp. 43–45.
"Adjusting the Crystal-Controlled Transmitter," S. P. McMinn.

The adjustments of a crystal-controlled circuit are easily made if proper precautions are considered. The operator of station 2 WC presents his experimental layout, consisting of one UX-210 oscillator, and two 203-A amplifiers, and explains the details concerning adjustment and operation. Proper precautions are necessary to avoid ruining the crystal in the oscillator plate circuit.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Roberts.*
Radio News. May, 1926, pp. 1562ff.
"Building the Roberts Circuit," A. MacGillicuddy.

The layout of a five-tube Roberts circuit is shown, information being given on the proper operation and neutralization of the set.

R134.4. REGENERATIVE ACTION. REGENERATION.
Rodio News. May, 1926, pp. 1564ff.
"What is Regeneration—Part II," K. W. Jarvis. (Continued from April issue).

A tube begins to oscillate at the point of "critical regeneration," says the writer. Regenerative amplification is said to depend on the choice of the tube and not the type of circuit. The effect of grid leak and condenser on regeneration, the explanation of "negative resistance" when speaking of regeneration, the effect of series resistance in the grid circuit, beat reception phenomena, the question of sharpness of tuning, and the effect of re-radiation from antennas are discussed in detail.

R344.3. TRANSMITTING SETS. TRANSMITTERS, *Schenectady.*
QST. June, 1926, pp. 33–39.
"South Schenectady and the April Tests."

The paper presents a short description of the various short-wave stations used in recent tests at Schenectady. These include 2 XAG, 2 XAH, 2 XK, 2 XAC, 2 XAF, 2 XAD, 2 XAW, and 2 XAF. The method of controlling the 20-kw. energy output from 2 XAF, using fifth harmonic and an UX-210 tube as master oscillator, is described.

R113. TRANSMISSION PHENOMENA. EARTH ELECTRICITY.
Popular Radio. June, 1926, pp. 111ff.
"Earth Electricity—Does It Affect Radio Reception?" E. E. Free.

The problem of earth currents, the amount, the changes, the source, and the effect on radio waves, is discussed. Radio waves are supposed to travel between two great electric charges, the positively charged upper air and the negatively charged surface of the earth. Near the surface a potential gradient averaging 150 volts per meter is found, this value decreasing with height. The negative charge of the earth is not a constant, but undergoes daily and seasonal variations which may or may not be regular. The negative charge on the earth is continuously being dissipated to the air, but at the same time constantly renewed from some source unknown, and little understood. The variation io earth potentials, results in earth currents flowing from places of higher potential to those of lower potential, and this flow is said to affect the travel of radio waves.

R550. BROADCASTING. MICROPHONE FRIGNT.
Popular Radio. June, 1926, pp. 114ff.
"Micro-Fright," Homer Croy.

The experiences of the writer, as he steps before a microphone for the first time, are related. He sets down four rules a broadcaster should follow. First, rehearse your talk or your song before you face the microphone. Second, bring your sheet music or your manuscript with you. Third, use a porous paper that does not crinkle when you turn the pages. Fourth, clear your throat before you begin to talk or sing. Several points a radio director should consider before placing a number on a radio program are mentioned and discussed.

R110. RAOIO WAVES. RADIO WAVES.
Popular Rodio. June, 1926, pp. 124–126.
"Radio Uses no Ether Waves," W. W. Massie.

Instead of accepting the Hertzian wave theory of radio wave propagation, the writer adheres to the magnetic wave theory. He explains his conception of wave transmission by stating that "Wireless signals are a wave motion, in, or disturbance of, the magnetic forces of the earth, and are propagated through this magnetic field, following the curvature of the earth, just as a tidal wave would follow the surface of the ocean. Practice indicates that the nodal points of the waves are at, or near, the earth's surface."

Accordingly, the magnetic field runs parallel to the surface of the earth and any disturbances set up are propagated along these magnetic lines of force. Also, there is a direct connection between earth currents and radio reception, the strongest signals being heard along the lines of earth current travel.

R343. ELECTRON-TUBE RECEIVING SETS. FERGUSON MODEL 8.
Popular Radio. June 1926, pp. 131–136.
"How To Get the Most Out Of Your Ready-Made Receiver," S. Gordon Taylor.

The Model 8 Ferguson receiver is described and explained in detail. The construction, the operation, the circuit and its theory, the correct tubes and batteries to use, and the design of the set, are all clearly outlined for the owner of such a set.

R. 342.7. AUDIO FREQUENCV AMPLIFIERS. AUDIO FREQUENCY AMPLIFICATION.
Popular Radio. June, 1926, pp. 138ff.
"Audio-Frequency Amplification," John V. L. Hogan.

The question "What constitutes good amplifiers and loudspeakers?" is considered. The loud speaker and the amplifying system are inter-dependent and must be so considered in the practical and theoretical analysis. A practical transformer should magnify uniformly between 64 and 6000 cycles per second, says the writer. Good amplification consists—first in efficient tube coupling apparatus; second, in the elimination of tuning or resonant effects or feedback conditions in the audio system; third, in using vacuum tubes large enough to handle the maximum output of the set without overloading; and, fourth, in the proper choice of a loud speaker.

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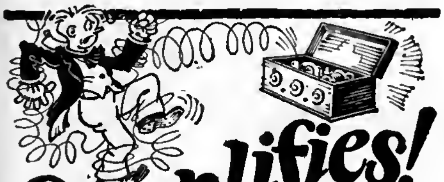

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R380. PARTS OF CIRCUITS; INSTRUMENTS. METERS, *Popular Radio*. June, 1926, pp. 141ff. *Use in Receivers.* "Use Meters to Avoid Breakdowns," D. B. Hill.
The use of meters in receiving sets is important. It is recommended that, if possible, four meters be used in recording the condition of the energy supply to the receiver. These meters, in their order of importance, are: Filament voltmeter, plate voltmeter, plate milliammeter, and filament ammeter. The practical use and the operation of each in its place is discussed.

R550. BROADCASTING. BROADCASTING. *Popular Radio*. June 1926, pp. 144ff. *Effects of* "Rebuilding Bodies by Radio," Sir B. Bruce-Porter.
The psychological effect that radio programs have upon the subconscious mind of people, especially upon the mind of a patient in a hospital, is told by the writer, who is head of the Third London General Hospital. Disordered minds are soothed by the broadcast programs and likewise morbid thoughts prevented.

R343.7. ALTERNATING CURRENT SUPPLY. RAYTHEON *Popular Radio*. June, 1926, pp. 147-151. POWER PACK. "The Raytheon Power-Pack, Part II," L. M. Cockaday.
Four models of Raytheon Power-Pack units are shown, together with blue-prints of circuit diagrams and lists of materials needed to construct each. The transformers selected for these models are All-American, Thordarson, Acme, and Precise.

R110. RADIO WAVES. RADIO WAVES. *Popular Radio*. June, 1926, pp. 155ff. "Can We Make Use of Millimeter Waves?", E. E. Free.
Doctor Langmuir suggests the use of millimeter waves for communication purposes, using new methods in producing these waves. He suggests some totally new device for generating and refers to similar devices which have been used, such as the iron-dust generator of Madam Glagolew-Arkedewa, or the vacuum tube having all parts enclosed in it, or a reflector method, or production of waves directly from heat energy. The radio amateurs in his opinion are best equipped to undertake such experimental work.

R113. TRANSMISSION PHENOMENA. EARTH *Radio News*. June, 1926, pp. 1624ff. ELECTRICITY. "Radio Reception by Ground Alone," S. R. Winters.
The experiments conducted by Doctor Rogers with his eight-tube super-heterodyne and underground radio system seem to indicate the advisability of further investigation. Static is said to be practically unknown and reception seems to be much improved. Earth propagation of radio energy is considered in relation to aerial propagation, reference being made to some other theories of wave travel, such as the Kennelly-Heaviside layer, and the Hertzian wave theory.

R381. CONDENSERS. CONDENSERS, *Rodio News*. June, 1926, pp. 1640ff. *Fixed.* "The Manufacture of Mica Coodensers," S. Siegel.
Fixed condensers must meet two requirements, namely, accuracy and electrical efficiency. In the manufacture of fixed mica condensers the mica must undergo rigid tests. Thorough impregnation, to guard against moisture, is necessary. Capacities may vary greatly, even after being assembled cautiously and as nearly identical as possible. Present patented processes insure more accurate capacity ratings now, even before making final assembly.

R535. FORESTRY. FORESTRY *Radio News*. June, 1926, pp. 1644ff. AND RADIO. "Static Forecasts Forest Fires," S. R. Winters.
The use of radio in detecting the relation of static conditions to forest fires has been fairly well established during the past few years. What are known as static stations have been in operation in various localities in the Northwestern forests where weather conditions, humidity, barometer readings, etc., are studied in comparison to static or atmospherics. It has been found that humidity increases with static, although daily and seasonal variations must be taken into consideration.

R342.15. AMPLIFIER TRANSFORMERS. TRANSFORMERS, *Radio News*. June, 1926 pp. 1662ff. *Audio-frequency.* "Audio-Frequency-Amplifier Transformers," S. Harris.
Good transformers must have output voltages which in every way correspond to the input voltages, so that the voltage ratio at any instant be a constant, says the writer. This idea is made clear by an extensive comparison of harmonics and frequencies of the musical scale to the natural characteristics of the transformer with its possible irregular amplification of harmonics and overtones over the audible scale.

R342.15. AMPLIFIER TRANSFORMERS TRANSFORMERS, *Radio News*. June, 1926, pp. 1665ff. *Constants of.* "How Transformer Constants Are Measured," S. Harris.
The measurement of transformer characteristics, voltage ratio, primary inductance, resistance, power losses, core losses, impedance, etc., are easily made by using the set-up described and illustrated. The circuit consists of an audio-frequency generator, an amplifier, the transformer under test, and the measuring instruments. The operation of the set-up is considered very simple, equations and mathematical deductions being presented to facilitate its use.

R160. RECEIVING APPARATUS DESIGN AND PRINCIPLES. RECEIVERS, *Design of.* RADIO BROADCAST. July, 1926, pp. 248-252. "Tendencies in Modern Receiver Design," J. G. Aceves.
In a paper delivered before the Radio Club of America, the author surveys the field of radio receiver design, classifying it as follows: (1) The regenerative detector; (2.) The neutralized radio-frequency amplifier with or without regeneration; (3.) The double detection or super-heterodyne types. These receivers are studied from various standpoints, namely: technical, acoustical, and operative, and in turn the radio-frequency amplifier, the detector, the audio-frequency amplifier, the translating device or loud speaker, and the source of power, are considered. Supplemented by various diagrams and curves, the article gives considerable information relative to the history and the developments of receiving sets in use to-day.

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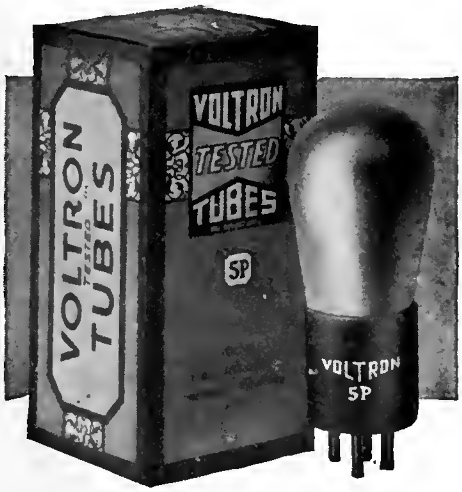

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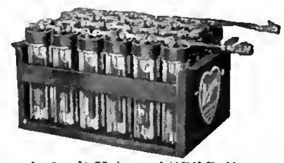

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THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

As WAS announced in the June Radio Broadcast, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, Radio Broadcast Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to Radio Broadcast will be answered free of charge.
2. Non-subscribers to Radio Broadcast will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in Radio Broadcast.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in Radio Broadcast "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

In response to many requests, lists of the various groups of apparatus tested and approved by Radio Broadcast Laboratory will be mailed to all inquirers without charge.

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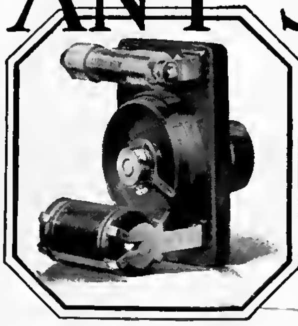
Errata

Two unfortunate errors crept into our August number on Lab. Sheet No. 20. Under the numerals, there should be five dashes for "Zero" while the code expression for "Transmission Finished" is dot-dot-dot-dash-dot-dash.

CRYSTAL CLEAR TONES ON ANY SET

Carborundum Detector *Stabilizing Unit*



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Another Dollar brings to you Radio Broadcast's Knock-out Four-Tube Roberts Receiver full-sized blue-prints.

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BOOK REVIEW

The Radio Fan's Vade Mecum

HOW RADIO RECEIVERS WORK. *By Walter Van B. Roberts, B.S.,E.E.,Ph.D. Published by Doubleday, Page & Company. 53 pages. $1.*

THERE has been a demand the last few years for a really comprehensive book, dealing with the principles underlying radio reception. The average set builder desires to know the functions of the pieces of apparatus he uses in a receiver, and gradually is inspired to go deeper and deeper into the subject. Most available books either are so elementary as to give one a misconception of the phenomena occuring or else they go into elaborate calculations so that the physical picture of the mechanisms operating are entirely lost.

"How Radio Receivers Work," by Walter Van B. Roberts, is a book which fills a long-felt need on the part of many radio experimenters. It gives the elementary electron theory in terms that anyone can grasp, with the help of the mechanical analogies used, and at the same time the ideas conveyed are physically accurate. A few pages are given to alternating current theory in which the function of a coil and a condenser is explained, as well as the circuit which results when inductance and capacity are combined in parallel, to form an oscillatory circuit. This latter circuit is really the foundation upon which any receiver is built, for without it, stations operating on different wavelengths would not be separated, and the word "selectivity" would drop out of our electrical vocabulary.

Antenna systems of various types are discussed, and one theory of fading is given which, though interesting, does not seem to explain some of the phenomena which are so readily taken care of by the assumption of the existence of a "Heaviside Layer".

Those who have wondered why a vacuum tube can be made to operate as either an amplifier, a detector, or a generator of alternating current, should read the third chapter of Mr. Roberts' book, where the principles of the tube, "The Aladdin's Lamp of Radio"—are discussed in everyday terms.

The latter part of the book deals with modern types of receivers, discussing different methods of radio frequency amplification, including the super-heterodyne and super-regenerative principles, as well as regeneration. Audio amplification, under the headings of "Impedance and Resistance Coupling," "Transformer Coupling," and "Push-Pull Amplification," are discussed. Thus, the important parts of the receiver, the r. f. amplifier, the detector, and the a. f. amplifier, are discussed as separate units, giving the reader the proper prospective on the complete receiver.

It should be apparent from this brief resumé that here is a book that the experimentally inclined radio fan can well afford to own, one that is a welcome addition to that only too small existing library of authoritative simplified radio texts.

GLENN H. BROWNING.

Another Radio Show

TO OUR list of radio shows scheduled for the coming season (this list was printed in the August RADIO BROADCAST), should be added the Omaha Radio Show. This latter will take place during the week of September 6th to 11th, and is being held under the auspices of the Omaha Radio Trade Association, in the Omaha Auditorium. Manager, Chas. A. Franke.

The New Balkite Charger

MODEL J. Has two charging rates. A low trickle charge rate and a high rate for rapid charging. Can thus be used either as a trickle or as a high rate charger. Noiseless. Large water capacity. Rates: with 6-volt battery, 2.5 and .5 amperes: with 4-volt battery, .8 and .2 amperes. Special model for 25-40 cycles. Price $19.50. West of Rockies $20.

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Balkite "B" eliminates "B" batteries and supplies "B" current from the light socket. Noiseless. Permanent. Employs no tubes and requires no replacements. Three new models. Balkite "B"-W at $27.50 for sets of 5 tubes or less requiring 67 to 90 volts. Balkite "B"-X for sets of 8 tubes or less; capacity 30 milliamperes at 135 volts—$42. Balkite "B"-Y, for any radio set; capacity 40 milliamperes at 150 volts—$69.

Balkite Combination

When connected to your "A" battery supplies automatic power to both "A" and "B" circuits. Controlled by the filament switch on your set. Entirely automatic in operation. Can be put either near the set or in a remote location. Will serve any set now using either 4 or 6-volt "A" batteries and requiring not more than 30 milliamperes at 135 volts of "B" current—practically all sets of up to 8 tubes. Price $59.50.

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All Balkite Radio Power Units are permanent pieces of equipment. They use no tubes. They have nothing to wear out or require replacement. They are noiseless. They do not hum. They always give just the power needed by the set because they do not run down or run low. Other than a slight consumption of household current their first cost is their last. With sets of high current requirements they effect a decided saving.

Operate your set with Balkite Light Socket Power. Over 600,000 receivers — one of every ten—are already Balkite equipped. Equip yours with Balkite and convert it into a light socket set. Know the pleasure and satisfaction of owning a set always ready to operate at its best.

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RADIO BROADCAST

OCTOBER, 1926

WILLIS K. WING, Editor

KEITH HENNEY, Director of the Laboratory

JOHN B. BRENNAN, Technical Editor

Vol. IX, No. 6

CONTENTS

BEHIND EDITORIAL SCENES

NOT only is this issue, the Metropolitan Shows Number of RADIO BROADCAST, by far the largest in point of editorial content, but it is certainly the most interesting we have presented our readers in many months. Although a special effort has been made to present in advance of the radio shows as much information as possible about what the visitor will see there and a special section of the magazine has been devoted to the radio shows, no change whatever has been made in the usual number of pages and quality of the regular section of the magazine. . . . Everyone, whether he knows anything about radio technically, or not, should find French Strother's article "Is There a Monopoly in Radio?" of deep interest. Mr. Strother, an associate editor and special writer on the staff of *World's Work*, is nationally known as one of the ablest special writers in the country. We believe that his series of three articles on the radio industry, of which this is the first, will be read with wide and deep interest.

THERE are four articles in this issue of great value to the home set builder. The first is a description by Zeh Bouck of a five-tube tuned r. f. set using the King Equamatic system. The second is constructional data on a fine power supply device, prepared by B. F. Roland, which furnishes A, B, and C potentials to the radio receiver. Many constructors have long awaited a dependable unit and we have no hesitation in saying that this will satisfy their requirements. McMurdo Silver's description of the construction and assembly of a six-tube completely shielded receiver provides the home builder with a set embodying all the latest and approved constructional ideas. And another of Keith Henney's articles on vacuum tubes appears on page 499. This series of tube articles have attracted more attention than almost any of the strictly technical articles ever printed in RADIO BROADCAST.

NOW for the November RADIO BROADCAST. The second of French Strother's articles on the radio industry will appear. Our feature constructional article will tell how to build the RADIO BROADCAST Lab. receiver, which many of our readers have awaited eagerly. George J. Eltz, Jr. has written an extremely interesting description of a short-wave superheterodyne which works on a small loop extremely well. The short-wave "super" is something the amateur has been attempting to perfect for a long time. This model is not hard to build and should attract wide attention. In addition to these articles of special interest there will be an interesting story by Senatore Marconi and a bookful of other articles which have made so many readers of RADIO BROADCAST say they would never miss a copy.

—WILLIS K. WING.

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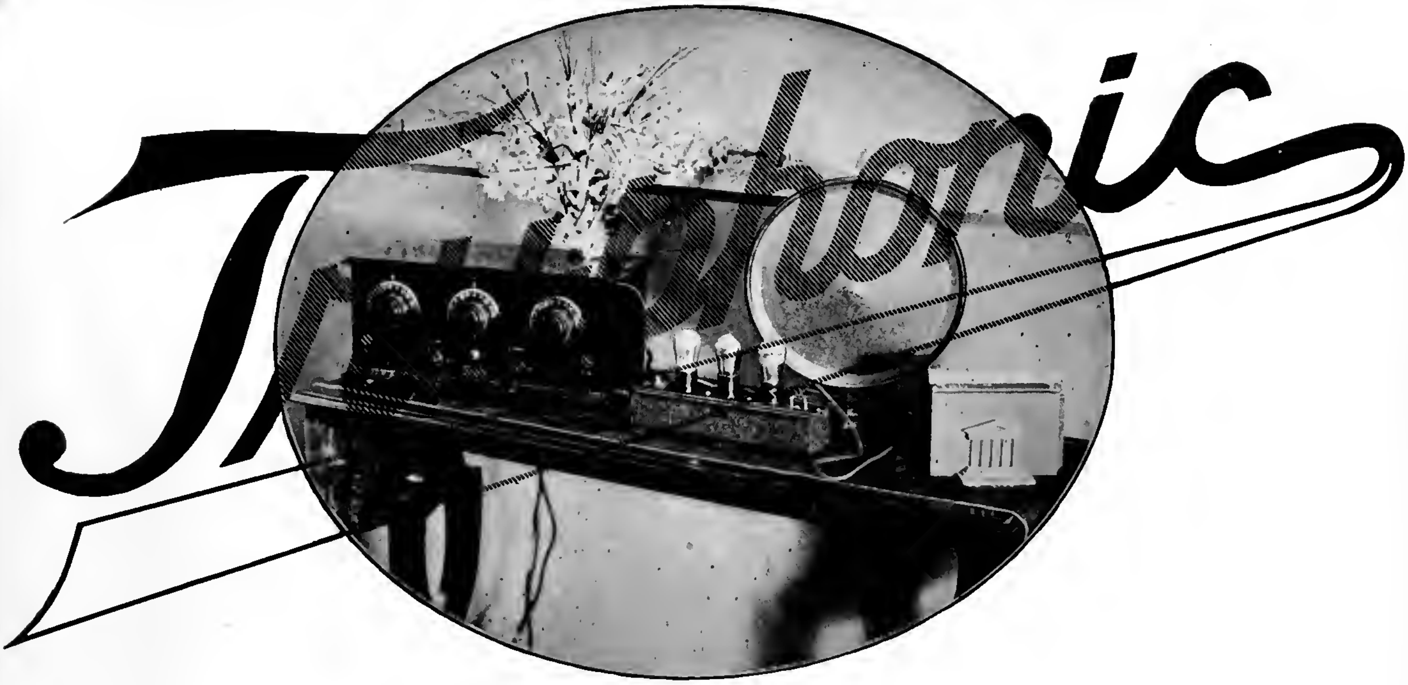

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as the name implies—*True Music*

Improved Amplification and Increased Power

THE most important part of a radio set is the amplification. With the phones on the detector, you get real music. Step to the last stage. You get a muffled roar for applause. The announcer ceases to be clear and understandable.

Attach the Truphonic Amplifier and all this is changed. The same clarity of the detector tube is preserved. You'll be surprised with what you were satisfied with before.

Just try the complete Truphonic Amplifier on any set. Clip the cables to the regular set batteries; shift tubes; plug in adapter and speaker. You'll never take it off.

One extra tube is all you need. If you like, you can use a power tube. Connections are provided. Also, the amplifier includes an output unit for the protection of your speaker. This choke and condenser output unit is recommended by the R. C. A. and others when power tubes are used. You get clearer tone, greater power capacity, and there is no danger of burning out or demagnetizing your speaker.

This Truphonic system is being adopted by many of the higher quality set manufacturers. Their endorsements after the most complete laboratory and practical tests are most wholehearted.

Truphonic amplification so operates as not to absorb weak signals as do heavy audio transformers and impedances. Its amplification is over double that of resistance coupling, with no extra batteries.

Truphonic amplification is a new system, developed by Mr. H. P. Donle. A balanced combination of transformer and impedance action, simultaneously transmitting energy by electromagnetic and electrostatic action exactly coordinates with the characteristics of standard tubes.

Engineers marvel that this compact device maintains such quality and seems impossible to overload.

In addition to the complete amplifier ready to attach to a set, individual couplers in separate iron clad cases are supplied stage by stage. The output unit is also mounted in an identical case. These units have a bracket arrangement that allows the case to be mounted in various positions. This, together with their compactness, makes it possible for service men to install them permanently in any set. Leads are attached for the convenience of the set builder. Every requirement of set design is fully met.

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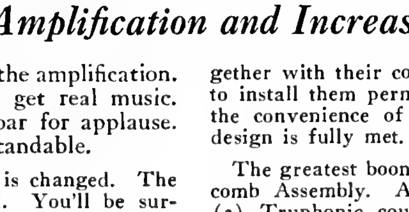

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RADIO EQUIPMENT ON A BRITISH PASSENGER PLANE

How a standard Marconi 150-watt vacuum tube telegraph and telephone radio transmitter is installed on an Imperial Airways passenger machine operating between London and the Continent. The illustration shows how the apparatus is tucked away in the cockpit of the machine. The pilot operates it from his seat by means of cable controls

RADIO BROADCAST

VOLUME IX — NUMBER 6

OCTOBER, 1926

Is There a Monopoly in Radio?

How the Structure of Invention and Patents Has Grown Up—The Healthy State of Confusion in the Radio Industry—The First of Three Articles Presenting a Study of the Present State and Probable Future of the Radio Industry in the United States

By FRENCH STROTHER

TO GET a broad picture of radio as it is to-day, and of what radio may be to-morrow, is the purpose of this article and the articles to follow it in this series. First, we shall try to present the facts about radio as an evolving art; then the facts about radio patents; and finally the facts about radio as a business. In so brief a space, only the most outstanding things can be noted, but they should give the key to the relative position and importance of the rest.

The present state of radio is the result of a process of evolution. Scientists, searching for pure truth, opened up new principles that could be applied to the transmission of sound. Inventors, building on their work, devised the practical apparatus for doing this. Business men, capitalizing the right to make and sell this apparatus, organized companies to exploit it.

It is important, if we are to understand radio as it is to-day, that we should recognize that these three classes of men work from different motives. The scientist works solely for new knowledge, with no thought of gain. The business man works solely for gain. The inventor works from a combination of the two incentives; if he were not scientific in his bent, he would never master the laborious technical knowledge necessary before he can apply his inventive genius; and if he were not anxious for gain, he would not try to convert his scientific knowledge into practical and saleable devices for general use.

As nearly all the science upon which radio is built was known fifty years ago, we shall have little concern with scientists in these articles. Taking their work for granted, as the old basis upon which the modern marvel of radio is built, we shall see that radio as we know it to-day is what it is because of three things: (1) the inventors, (2) the business men, and (3) the patent laws.

Nobody "invented radio." The theory of radio was known long before anybody was able to apply it to practice. Numerous inventors were trying to devise apparatus that would make the theory work. For this reason, several different practical systems of wireless telegraphy appeared at about the same time. Marconi had the good fortune to be the first, but he distanced his nearest competitors by only a short time. Indeed, it was only by accident that electrical communication by wire was perfected before electrical communication without wires, for both are implied in the electrical knowledge that preceded both, and inventors were working busily in both fields for many years before anybody in either group succeeded.

The search for a means of wireless communication continued with redoubled zeal the moment that communication by wire was achieved. The basic science upon which wireless is founded is at least as old as Sir Isaac Newton, who wrote to his friend Bentley his scornful opinion of anybody who doubted the existence of what we call the ether. All the great students of electrical phenomena, including Ampère and Faraday, made experiments demonstrating the reality of this medium, which is capable of transmitting undulations which we have always been able to perceive as light, and which, by virtue of the development of radio, we are now able to perceive as sound.

FOR many years, Mr. French Strother was Managing Editor of World's Work, *and he has long been known to readers of that magazine as a writer of unusual insight and refreshing clarity.* RADIO BROADCAST *counts it a great privilege indeed to present this article, which is the first of a series of three, devoted to a searching analysis of the radio industry in the United States. One hears much loose talk about monopoly in radio; some have even put their opinions more strongly than that. Mr. Strother, accordingly, set out to analyze the situation in the industry and we are certain that his three articles will not only prove interesting reading, but will furnish material for a great deal of thought—along slightly different lines than has been the case heretofore—for the many who are associated in one way or another with this great industry. In the preparation of these articles, a great number of radio executives were freely consulted, and as freely provided information. No effort has been spared to make these articles as fair and as accurate as possible. The next one of the series will appear in an early issue.*—THE EDITOR.

LOOKING BACK TO 1888

MARCONI'S first experiments with wireless telegraphy were made in 1895, but his work was based directly upon the discoveries of Hertz, announced in 1888, and of Branly, announced in 1890. Hertz was the first scientist to set up controlled electric undulations in the ether, by means of a mechanical device called the Hertz radiator, and to receive these undulations, by means of another mechanical device, called the Hertz resonator. Branly of France invented the coherer, or tube containing metal filings loosely packed between metal plugs, which provided the first practical device for "making and breaking" the circuit, at the receiving end—necessary if telegraph messages were to be transmitted by wireless.

Marconi improved upon

Hertz's method of setting up ether waves, and he improved upon Branly's coherer. Marconi then did a new thing that neither of the others had done, namely, he made a practical combination of his improvements on their two devices, by which he was able to transmit and receive telegraphic signals, over distances measured, not by feet in a laboratory, but by miles over land and sea. Marconi, therefore, properly ranks as a great inventor; but he did not invent radio. He did invent the first practical system of wireless telegraphy.

The next great invention in wireless was the tube. This was invented by an English scientist, J. A. Fleming, who called it a "valve," the name by which tubes are still known in England. Fleming also utilized previous discoveries to make a practical invention. It was known before his day that rarefied gases would conduct electrical currents under certain conditions. Fleming invented a practical device for using this property of rarefied gases in the reception of wireless signals. He confined them in a sealed glass bulb, into which he introduced also the incoming and outgoing ends of a broken electrical circuit. One of these ends, the "filament," he heated by a battery independent of the electrical current he wished to control. The other end was a cold "plate." He observed that the passage of the current through this device could proceed in only one direction—from the hot element to the cold element. Because this action was equivalent to the action of a valve in mechanics, he called his tube an electrical valve. It may be noted, in passing, that Fleming's valve was in a sense only an improvement upon Branly's coherer, although the electrical action of the two devices is vastly different. Fleming substituted rarefied gas for metal filings, and added a means of heating one of the two electrical connections. But these improvements were enormously important, because they made the coherer infinitely more sensitive, wholly automatic, and controlled the direction from which the undulations of the ether should be received.

WHERE THE PATENTS START

THE bearing of all this on the radio art that at present concerns us is this: the scientists, from Newton to Hertz, were interested only in *laws of Nature*. So, too, to be sure, were Marconi and Fleming; but when Marconi assembled a *practical device* for transmitting telegraph messages without wires, he *patented the device*. And when Fleming invented a *valuable device* for improving Marconi's telegraph system, he too, *patented the device*. In other words, the moment pure science had carried an art to the point where there was "money in it," a struggle began to control the instruments which made the practical applications of the art commercially profitable. That struggle has persisted to this day, with ever-increasing fury, as the increasing practical applications have widened the opportunities for commercial profit.

The present patent tangle in radio will be better understood if we follow the Marconi and Fleming patents one step further. Marconi owned the patent on the (then) only practical system of wireless telegraphy. Fleming owned the patent on the best detector (which was his "valve" or tube) then available. If Marconi wanted to use the best detector in his own invention, he must "do business with" Fleming. If Fleming wanted to get any commercial advantage out of his invention, he must "do business with" Marconi. But if Marconi simply wanted to get the most he could out of his own inventions, and head off competition, he could refuse to buy rights in Fleming's patent and refuse to allow anybody else to make the other patented elements of his wireless system to which they might add Fleming's improved detector.

This first simple conflict of financial interests in radio was a foretaste and a prophecy of the present enormously complicated conflict. From the day that Marconi took out his first patents it was certain that every subsequent inventor in radio would patent *his* invention. And from the day that Fleming took out his first patent, it was certain that every additional patent would involve a new conflict of financial interest. The reader may imagine for himself what that means to-day, when there are twenty-four hundred unexpired patents on radio subjects in the United States.

HOW THE TANGLE IN RADIO PATENTS BEGAN

ANOTHER suggestion needs to be made at this point, to help understand why the patent situation so bedevils radio. Science and business differ in a fundamental respect. Science, by its very nature, seeks change and progress. To the scientist, the discovery of a new principle or a new device merely pushes back one step the frontiers of the unknown which he is eager to explore. Hence, one scientific discovery is merely an invitation to the scientist to make the next discovery that lies "up that street." The faster he progresses, the happier is the scientist.

Business, on the other hand, cannot progress so fast. To make a commerical success of even one practical application of science calls for a heavy outlay of money in patent rights, factory, machines to manufacture the device, men to operate the machines, salesmen to sell the device. All this money must be laid out before one dollar of return begins to come back. And the venture is not a success until all the original investment has been recaptured in the form of profits, and something besides gained to pay for the trouble of organizing the enterprise.

Now add this difficulty to the radio situation, and you may imagine how the present semi-chaos came about. No sooner had Marconi started to do business under his patents than a dozen inventors came along with improvements so radical that Marconi either had to control them or be left hopelessly in the rear of the advance of the art. Fleming's "valve" was a better detector than Marconi's. Soon there came along De Forest's Audion, which was vastly better than either. Then along came Fessenden, with his device for producing "continuous wave" emanations instead of alternating oscillations, making radio transmission so flexible that it became possible to transmit the complex modulations of the human voice or the symphony orchestra. Where did these advances leave Marconi, with his now crude mechanical coherer and his "spark" telegraph circuit? Commercially, where did it leave his financial backers, with their hopes of profit from devices that were antiquated before a dozen of them could be got on the market?

Multiply this dilemma by two thousand, and you may perceive clearly both what and why the present tangle in radio patents is. On the one hand, the joy of scientific discovery urges a thousand scientists and hundreds of thousands of amateurs to try to find new ways of using radio, or better ways of doing the things already discovered. On the other hand, the hope of profits to be earned by exploiting discoveries already made and patented urges business men to try to control every avenue of advance in the art, so that each new device may be used until it has returned its cost and a profit before the next and better device permanently replaces it. The law of the

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NOBODY invented radio. The theory of radio was known long before anybody was able to apply it to practice. Numerous inventors were trying to devise apparatus that would make the theory work. For this reason, several different practical systems of wireless telegraphy appeared at about the same time. Marconi had the good fortune to be first, but he distanced his nearest competitors by only a short time. Indeed, it was only by accident that electrical communication by wire was perfected before electrical communication without wires, for both are implied in the electrical knowledge that preceded both, and inventors were working busily in both fields for many years before anybody in either group succeeded.

"The search for a means of wireless communication continued with redoubled zeal the moment that communication by wire was achieved. The basic science upon which wireless is founded is at least as old as Sir Isaac Newton, who wrote to his friend Bentley his scornful opinion of anybody who doubted the existence of what we call the ether."

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land largely determines the extent to which the scientific interest or the financial interest shall control the development of the art.

WHAT HAS HAPPENED IN GREAT BRITAIN

FOR this reason, it is worth while briefly to compare the development of radio in Great Britain and the United States. Marconi took his inventions to Great Britain, patented them there, and undertook to exploit them commercially there. Fortunately for him, British law makes any system of communications a Government-controlled monopoly. Radio inventors in Great Britain, desiring to profit by their inventions, have necessarily to deal with Marconi, who, for practical purposes, is the British Government. How soon their inventions shall be used, and to what extent, is determined upon business principles, which demand an orderly commercial development of the whole radio structure, including telegraphic communication, broadcasting, and home reception.

The result in Great Britain has been that most of the subsequent important radio inventions have been made in the United States. Other results have been that the per capita consumption of radio apparatus in Great Britain is incomparably less than in the United States. Both the art and the business of radio have suffered in Great Britain. The one notable exception to this statement is that Marconi has not suffered in a business sense. He, at least, has enjoyed the fruits of monopoly—though it is debatable whether he might not have profited more if he had had competition and consequently a wider market in America.

In the United States, on the other hand, we have laws that provide for a patent monopoly but not for a monopoly of patents. We assure to each inventor a monopoly of the profits to be made from his invention; but we leave to the free play of competitive economic forces the extent to which his monopoly, on his invention, is combined with other monopolies, on other inventions. In this country, therefore, we have business groups that have acquired some of the important radio patents, competing with other business groups that have acquired other important radio patents. No one group has yet been able to corral all the essentials of radio into one lot, and thereby free themselves from the necessity of using every effort, to be more inventive than everybody else, to be more skilful in manufacture than everybody else, and to be more energetic and able in selling their product than everybody else.

IS THERE A RADIO MONOPOLY IN THE UNITED STATES?

THE Radio Corporation of America is very generally charged with trying to occupy that position in radio in the United States. However, the Radio Corporation does not now distribute as many radio sets as its largest competitor and it has offered to license several competitors under its patents—an offer which was refused. Consequently there is evidence that the Radio Corporation has neither the opportunity nor the desire to become a monopolist in the manufacture and sale of radio sets or parts. This does not mean that the logic of an industry based upon patents as the radio industry is, does not lead to the conception of a concentration of all the patents (which are monopolies) in the field. When that concentration is sufficiently effected so that the rights to use enough patents to make a set are available, who will use them, one concern or many? If there are many, there will be competition.

Competition thus far has justified itself by its fruits. The enormous public interest in broadcast reception has been made possible by the ease with which the listener could secure a receiving set, either by building it himself or by buying his choice of hundreds of ready-made designs. This public interest has created a market of such vast proportions that even a would-be monopolist's share of it is doubtless larger than he could have got by monopolizing the more restricted market which monopoly creates. But, of course, anyone contemplating a monopoly would not be thinking only of the present. He would be thinking of getting a strangle-hold on the future, so that when the industry does become as big as they pre-vision it, he would enjoy all the profits of it.

Let us, then, review the present situation of radio in the United States, to see, if we can, what likelihood there is that radio will ultimately become the monopoly of one business group. Or, failing that, what the probable development will be.

From what has been said above, it is clear that the answer will not be found in patents alone. Patents are only one of the raw materials upon which a great industry feeds. With them must be put great sums of money, invested in factories and machines. With these must go great manufacturing skill. Added to these must be great skill in salesmanship and the details of commerce. And finally there must be the rare and peculiar type of genius, called, in French, the *entrepreneur*, whom for lack of a single word in English, we call the "captain of industry" or the "statesman of industry"—the man who combines the power to survey a whole field of business enterprise, vision its possibilities, secure capital, organize men of all the diverse kinds involved in invention and manufacture and sale.

The question, therefore, is not only "who invented what" in radio, and who now owns the inventions; but the question also is, who can best make radio apparatus, who can best sell it, and who, if he exists, is the genius that can combine these multiform elements into a stable industry?

These articles are designed to give the reader as many useful facts as possible in answer to these questions, and to suggest some of the possible combinations of these facts as they may tend to determine what radio is coming to in America.

At present, the radio art and the radio patents and the radio industry are in a state of chaos. On the whole, it is a healthy condition, because its very uncertainties stimulate the hopes of inventors, the opportunities of the listening public, and the enterprise of business men. But it is a chaos that cannot last, because inventive possibilities will ultimately become narrower and narrower; economic pressure will force out unskilful manufacturers and unwise commercial adventurers; and the courts will finally award each of the important patents to some one of the numerous claimants. Then the field will be clear for the business statesman to emerge with a practical monopoly in his hands; or, failing that, a group of friendly competitors will survive, as in the automobile field, cultivating various parts of a market big enough for all.

The two articles that follow this will deal separately with the two most important elements in the present radio situation. The first article will discuss the complicated patent situation that surrounds the various essential parts of a radio receiving set—the inventors, and the inventions, and the patents. The second article will deal with the business side of radio—the business men and the business groups and the question of monopoly.

Highlights From This Article

FROM the day that Marconi took out his first patents, it was certain that every subsequent inventor in radio would patent *his* invention. And from the day that Fleming took out his first patent, it was certain that every additional patent would involve a new conflict of financial interest. The reader may imagine what that means to-day, when there are twenty-four hundred unexpired radio patents in the United States."

. . . .

"In the United States, we have laws that provide for a patent monopoly, but not a monopoly of patents. We assure to each inventor a monopoly of the profits to be made from his invention; but we leave to the free play of competitive economic forces the extent to which his monopoly, on his invention, is combined with other monopolies, on other inventions."

. . . .

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. . . .

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THE MARCH OF RADIO

News and Interpretation of Current Radio Events

The Wages of the "Wavelength Pirate" Is Unpopularity

PESSIMISTS feared that bedlam on the broadcast frequencies would be the inevitable result of the failure of Congress to provide radio legislation. Fortunately, nine out of ten broadcasters have realized the serious consequences arising from a destruction of the delicate wavelength structure which Secretary Hoover and his able assistants have built up during the last few years. At this writing, confusion has been limited to one or two highly congested areas.

Comparatively few stations have taken advantage of the legal loopholes which the Courts and the procrastination of Congress have provided. Few have taken excursions into the lower frequency end of the broadcast band, heretofore reserved for the well-established pioneer stations. So consistently have the "pirates" failed to find these coveted wavelengths free of interference that their reward has been, in almost every instance, nothing less than public contempt. Their incompetence as broadcasters has been accentuated by a continuous heterodyne whistle which accompanies their mediocre programs.

It is a tribute to the Department of Commerce that no real loop holes in the ether have been found by these self-seeking small boys of broadcasting. Before the summer is over, we may expect about 65 new stations and, in addition, attempts on the part of 48 or so existing stations to shift their wavelength upward. Until court decision, injunction, or legislation restores regulatory power, the listener's patience will be tried by exasperating interference. As a result, the position of the tried and true veterans for broadcasting will be still better established and their would-be imitators discredited. The public is being forcibly convinced of the undesirability of increasing the number of broadcasting stations. Legislation will be all the more drastic in its restrictions because of this distressing spectacle.

The spirit of fair play demands that the case of the "little downtrodden broadcaster" be heard without prejudice. Who are these broadcasters, seeking a place in the wavelength spectrum? Have the moguls of the ether been granted exclusive wavelengths and liberal time on the air at the expense of small deserving stations? Would it not be ideal to give all who wish full opportunity to broadcast when they please?

When broadcasting had its beginnings, some were far quicker than others to perceive its possibilities. These risked capital, erected stations, gained experience, established listener followings and won their right to a wavelength by rendering service. Others, after seeing the good will return accruing to these far-sighted pioneers, decided to go and do likewise. Many of these belated publicity seekers rushed, madly erecting stations without first ascertaining whether there was room for them on the air.

The situation from which we now suffer is the clamor of these late-comers to get on the air. Their invasion was postponed by the Department of Commerce until the Courts proved it to be without authority to deny them licenses.

These disturbers of the air cannot win the good will they seek. Even though we grant that their motives are no less altruistic than their predecessors, they are unwelcome to the broadcast listener. By interfering with reception from well established favorite stations, they incur only enmity. There is no room for them on the air.

The extent of public antagonism to interference from overlapping broadcasting stations may be gained from reviewing the results of a questionnaire sent by RADIO BROADCAST to 2000 of its readers in all parts of the country. Asked what progressive movements in radio they wished

The illustration forming the heading is a view of the apparatus at the 2 LO London station of the British Broadcasting Company atop Selfridge's store. Three kw. is the input to the antenna supported, 35.5 per cent. urged the elimination of radiating receivers and 32.7 per cent. voted for the discouragement of mediocre stations and relief from overcrowded conditions of the ether. No other question was mentioned by 5 per cent. of those answering the inquiry.

There are 92 channels between 1480 kilocycles (202.6 meters) and 550 kilocycles (545.1 meters). Fourteen of these are required for foreign stations, leaving 78 for American broadcasters. Two thirds of this band, providing 52 channels, is needed for stations of 500 watts power or more, with exclusive channels for stations in the center of the country and those of 5000 watts power or more. This allows for about 75 high grade key stations. On the remaining 26 channels is ample room for small stations, serving only local areas, using 250 watts power or less. Five hundred-mile separation can be maintained, giving room for 6 stations per channel, a total of 256 small stations.

The public would be amply served by the three hundred or more stations thus provided. It could ask for no greater boon from Congress than a law forbidding a greater number in the present band.

Is the "Air" Really Free?

"FREEDOM of the air" is a most tempting phrase to the professional agitator and persons of liberal tendencies who do not know the ether's limitations. They use the smashing phrase with grand effect, as they describe how great corporations and grasping monopolies have despoiled the people's ether, so that they may spread pernicious propaganda. They plead for a "free ether" which anyone may use to spread his personal opinions at will.

But this picture is much distorted. The other *does* belong to the people, but it cannot be free to anyone who cares to use it. It is a highly circumscribed medium with a definite limit to the number it can accommodate. Its indiscriminate occupation without restriction spells its utter destruction and nullification.

Nevertheless, the ether is not so limited that its use need be denied those who have an appreciable following. There are plenty of stations with liberal views sufficient to entertain all but the most rabid and extreme. Any speaker who has a real message which the public wants to hear has no difficulty in gaining access to the microphone. Program managers are keenly alert to the wishes of their audiences. We would wager if five hundred bona fide uninspired requests were received by *any* broadcasting station for *any* available speaker, he would be promptly invited by its program manager.

The Radio Corporation Rises to Ascendency in the Broadcasting Field

WITH the forthcoming withdrawal of the American Telephone & Telegraph Company, radio broadcasting loses the most constructive single influence which guided it through its early days. WEAF was the pioneer commercial station which not only formulated and established the present method by which the public pays for broadcasting but it created such high standards for commercial programs that it robbed the method of its undesirability. This is a permanent and significant contribution to the foundations of broadcasting.

Nevertheless, few will regret the disappearance of the A. T. & T. from the air, as long as the standards which it established are adhered to. Its business is wire communication. In that capacity, it will continue to serve broadcasting by supplying high quality transmission circuits for interconnection of stations and the supply of programs from remote points.

One of the principal objections to the A. T. & T. in the broadcasting field was its tremendous size and influence. It made beginners in big business tremble in spite of its helpful and constructive attitude. (We must admit that the leaders in radio to-day are only beginners in big business). Through patent holding it was in a position to exercise a monopoly in commercial broadcasting and did so for a long time. But broadcasting has become too big to be the side line of the largest corporation in the world.

The Radio Corporation of America now becomes the principal operating company in the broadcasting field. It will control the principal broadcasting chain in the country—the combined Radio Corporation, General Electric, and A. T. & T. group. It is now supreme in broadcasting, in the international radio telegraph business, and the ship to shore communication field.

Its future status in the business of selling receiving sets has not, as yet, been clarified. There are unconfirmed rumors afloat to the effect that the Radio Corporation will con-

THE HIGH POWER RADIO STATION AT RIO DE JANEIRO

The station is designed to communicate with the United States and Europe and is operated by an international combine of radio interests known as the A. E. F. G. The Radio Corporation of America is one of the interests. The large illustration below shows the 800-foot masts, transmitter building, and staff headquarters. The insert shows a close-up of the transmitter building. On either side are lead-in bridges carrying antenna and counterpoise wires on great heavy insulators

A CORNER IN THE BRITISH BROADCASTING COMPANY'S LONDON STATION

Many of the British programs originate in London and are forwarded by wire to outside stations in the chain. The various switchboards in use are used to supply programs to the provincial stations. The circle shows a close-up of the boards. By means of various distributing points, it is possible to tie up any or all of the twenty-one B. B. C. stations in any combination. The Daventry high power station takes practically all of its material from London

fine itself to these three operating fields and that the General Electric, Westinghouse, and Western Electric will manufacture and market their receiving sets under their own names. The products of the first two mentioned are well known to the public, having been sold to them under the brand name "Radiola," but the Western Electric will be a newcomer to the vacuum tube and receiving set field. Its experience in building high grade telephone equipment, its tremendous research facilities and its knowledge of radio design and construction place it in an enviable position so far as the making of high grade radio equipment is concerned. Most of the best broadcasting stations in this country are W. E. Company products and the excellent "double-detector" (super-heterodyne) receivers which are also a part of such a stations' equipment are made by the Western Electric Company.

Changes in Radio "Big Business"

WHEN the full purport of the negotiations which have been under way for a score of months, leading to a re-allocation of the functions of the various corporations in the Big Five group (General Electric, Westinghouse Electric, Radio Corporation, Western Electric, and Wireless Specialty Apparatus Company) become more generally known there will probably be the customary monopoly talk on the part of those who raise that hue and cry at every opportunity. But there is every reason to believe that the public will benefit greatly by the contemplated changes.

The augmented Radio Corporation chain will constitute a virtual monopoly of commercial broadcasting in the single sense that it is the only chain that approaches even to a degree national coverage for commercial advertisers. With this improved facility will come even better commercial entertainment programs. The public will benefit by a quality of broadcasting which is not equalled anywhere in the world, the rather definite statements of our British friends to the contrary.

The ability to do a thing better than any one else is a very sound foundation for an unrivalled enterprise. Anyone who wishes to rival this chain, having sufficient capital and brains, will find it possible. Broadcasting stations can be combined and wire lines hired to link them. Commercial broadcasting has not yet developed to the point where two competing chains can be profitably maintained. When that day comes, the rival chain will come into being promptly. Broadcasting monopolies can be retained only by cornering good will with clean and desirable features. On that basis, we may welcome monopolies, real or fancied.

The Progress of Radio Patents in the Courts

IN AN opinion handed by Federal Judge Thomas Thacher recently, the rights of the Hazeltine Corporation and the Independent Radio Manufacturers, Inc.,

THE MOST FAMOUS BRITISH AMATEUR, GERALD MARCUSE

Using call letters G 2 NM, Mr. Marcuse transmits code and radio telephone signals from his station on 7496 kc. (40 meters) regularly. He has frequently been heard in the Laboratory of RADIO BROADCAST on both code and phone at about 6 P. M. New York time. He works a regular schedule with Canadian 1 AR on 7496 kc. and has often relayed the transmissions of 2 LO, the London broadcasting station of the B. B. C.

to the Hazeltine patents were upheld. The Electric Service Engineering Corporation, against which the Hazeltine interests brought suit, contended, among other things, that the professor had made his inventions while in government service and that, therefore, they were public property. Judge Thacher, in his decision, described the difference between the Rice and Hazeltine patents and asserted that the plaintiff had attained "permanent neutralization for all frequencies, a result never attained before and one which had, as the evidence discloses, an astounding effect upon the entire industry."

Another decision handed down by Federal Judge Inch held that the Hazeltine inventions did not infringe patents owned by the Radio Corporation. The R. C. A. placed its principal hope in the Rice patent.

In Canada, W. W. Grant, maker of regenerative sets, won a case from the Canadian Westinghouse Company which charged infringement of Armstrong patents. Grant has been making regenerative sets since 1919, which is prior to the issuance of the Canadian Armstrong patents. The decision pointed out that the application for Armstrong's patents was made too long after the American patent had been issued to give him exclusive rights in Canada.

A decision very recently rendered by Federal Judge Thompson in the Federal Court of the Eastern District of Pennsylvania supported the claims of the DeForest Radio Telephone & Telegraph Company against the Westinghouse Electric Company. This much litigated patent will probably be the subject of legal battles to the day of its expiration.

Just what the results of this far-reaching decision will be is not yet clear. The Westinghouse Company has collected substantial royalties on the Armstrong patent.

Rushing In Where Angels Are Decidedly Absent

CAPTAIN P. P. ECKERSLEY, Chief Engineer of the British Broadcasting Company, is quoted in *Wireless* (London) as follows:

Broadcasting in America is chaotic. There is no organization in the United States, and advertising through the ether has been the means of its downfall. Broadcasting in America is a private enterprise relying entirely on advertising for its working expenses. There are no listeners' licenses or fees of any kind, and both the broadcasting companies and the listeners regret this.

They now feel that if broadcasting had been one official organization, as it is in England, it would be the most popular entertainment in existence. As it is, it is nothing of the kind. The craze is dying off and the public is getting bored. I might be accused of undue modesty when I say that the broadcasting service of England is undoubtedly the finest ot its kind.

Captain Eckersley then went on to say that American broadcasting is now faced with the gigantic task of finding enough money to give the public what it really wants. And, he claims it can't find the necessary finance.

Continuing, Captain Eckersley contributes a sample of how American broadcasting is conducted:

2PMS calling. You will now have the pleasure of hearing a group of cowboys singing "The Wild and Woolly West," this item being broadcast from the famous slaughter-houses of Chicago.

Then there is a rousing chorus all about beef on the march, the chase on horseback, the lassoing and the final capture. The housewife who listens in to this is out shopping next morning. The value of this indirect form of advertising is seen when she says: "I want two pounds of bully beef and I want it from the Chicago slaughterhouses!"

This may sound humorous to you, but would the British public stand for it? The answer is an emphatic No. Nor would it like to hear the Savoy Orpheans Band cut off by a strident voice shouting: "Buy Pop's soap! Buy Pop's soap! Buy Pop's soap!"

Then there is the American dramatic sketch as reported by Captain Eckersley:

"George, if you don't come back, I shall kill myself."

"Very well. Use a hypodermic syringe. You can get a really good one at Blank's drug stores on Broadway."

To American listeners, enjoying the extraordinarily high standard of commercial programs, Captain Eckersley's statements certainly sound ludicrous. Evidently the pressure in favor of permitting commercial broadcasting in England is requiring pretty strong counter-propaganda.

We rarely hear any clamor in the United States for a system of taxing listeners directly for the support of an absolutely iron-clad broadcasting monopoly. It is true, under these conditions, that wavelength problems would be lessened and regulation simplified. But we could not conceive of any monopoly which would retain a small proportion of the present enterprise and initiative of our program directors of to-day or one per cent. of the popularity of our present method of paying the broadcast bill.

We cannot understand why Captain Eckersley should draw so heavily on his imagination to invent his description of American broadcasting. Our bread is returning to us, buttered. The American has been criticised for singing the praises of our institutions beyond all reason. But here is Captain Eckersley, straying from his own technical field, to comment in this curiously inaccurate manner about American broadcasting.

The Month In Radio

AN ANNOUNCEMENT from Berlin advises that the passenger aircraft on certain important routes will be equipped with radio telephone apparatus linked with the wire telephone system of the country. While there is nothing new about this feat, it having been accomplished in this and other countries during the war, the German experiment will be the first time that it is done as an ordinary commercial service.

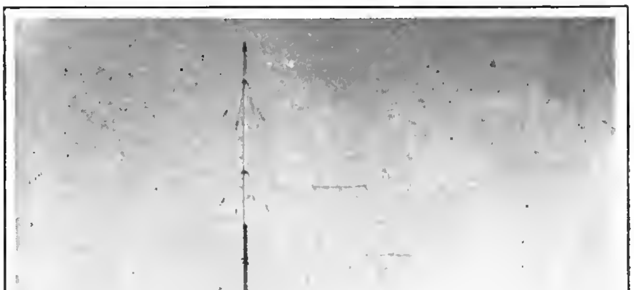
STATIONS 3 LP, 4 ZG, and 5 CL of Melbourne, Brisbane, and Adelaide, Australia, have increased their power to five kilowatts, which makes the chance of hearing them on the Pacific Coast a little less remote.

THE radio show season is not limited to the United States. Radio will be featured in Berlin at the Third Annual Radio Fair, at the Vienna International Fair and at the Leipzig Trade Fair. It is understood that there are several American exhibitors at each of these fairs.

ALTHOUGH there is considerable interest in broadcasting in Spain, 95 per cent. of the receiving sets in that country are said to be imported.

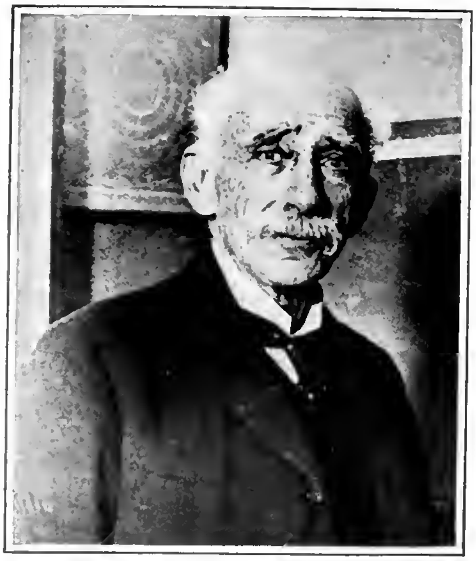
THE Haitian Government Department of Public Works has purchased a one kilowatt broadcasting station for installation at Port-au-Prince in order to disseminate entertainment features, items of public interest and lectures on health and educational matters.

THE Swedish Government has appropriated $287,500 to build its seventeenth and most powerful broadcasting station. It is to be erected by Marconi's Wireless Telegraph Company and will be of the same design and



ANTENNA SYSTEM OF THE PRAGUE RADIO STATION

This broadcasting station is a standard Western Electric 5 kw. outfit. The antenna is described as an Alexanderson type with three leads



DR. J. A. FLEMING, D. SC., F. R. S.
London

From an article by the inventor of the two-element tube in the *Radio Times*, London:

"On the question of remedies (for interference caused by regenerative receivers), it is difficult to prescribe. It might be possible to register possessors of reaction (regenerative) sets or to mark it on their licenses, but it would be difficult to secure accuracy. Any very flagrant or repeated offender, when discovered, should have a warning that his General Post Office wireless receiving license may be cancelled, or a fine imposed. Perhaps the best thing is to bring home to the public generally the full reasons for the trouble, and the cure for it, and to create a widespread feeling that it is not 'playing the game' to allow one's set to oscillate knowingly or unknowingly. The number of deliberate sinners is small."

power as the famous Daventry station. The company controlling broadcasting in Sweden reports a profit of $55,351 for 1925, after meeting a deficit of a little over $3000 incurred in 1924.

A SURVEY conducted by the *Dakota Farmer* reports that there are radio sets in 13 per cent of the farm homes of Minnesota, 17 per cent. in North Dakota and 12 per cent. in South Dakota. In view of the prosperous condition of this group of states, a substantial profit to those handling radio is predicted.

MIDSUMMER radio conferences are being held by the Northwest Radio Trade Association in six cities, scattered through the Ninth Federal Reserve District. About 1500 miles will be covered by rail in special cars and contact will be made with radio dealers serving an area of about 40,000 square miles. About 100 representatives of wholesale houses, manufacturers, and newspaper men will go on the sales boosting tour. This aggressive spirit is a decided contrast to that displayed by some of the trade associations and assures that one section of the country will be served by the best possible sales and servicing methods.

WITH a farm population of well over half a million, there are only slightly in excess of 12,000 farm radio sets in Nebraska, according to a recent survey.

THE latest report of licensed radio listeners in Great Britain shows a total of 2,120,252, according to figures of the British Broadcasting Company.

A HIGH power radio telegraph station will be erected at Manila by the Radio Corporation of America, according to plans recently approved officially. The station will link the Philippines directly with the United States, without recourse to foreign communication systems.

AT THE Atlantic City meeting of the National Electric Light Association, it was disclosed that there are 13,460,000 home consumers of electric current. Only 7.8 per cent. of the farms in the country have electric service of any kind. Fortunately radio does not have to wait for power lines, thanks to efficient dry-cell tubes and A and B batteries.

A SHORT-WAVE communication system for emergency use is to be installed by the Chicago, Milwaukee and St. Paul Railroad system, involving transmitting and receiving stations at Chicago, Milwaukee, Minneapolis, Miles City, Butte, Spokane, Seattle, San Francisco, and Omaha.

A SUMMONS read into the microphone of a broadcasting station was considered as a legal serving of process by Supreme Court Justice J. B. M. Stevens of Rochester, New York. Mrs. Lena F. LaPierre thus served notice of suit for divorce upon her husband who left Elmira for Rochester in 1920, utilizing the facilities of WHEC at Rochester for the purpose.

If such a flimsy method of serving summons becomes recognized in law, it will practically nullify the fundamental purpose of the summons. The chance that Mr. LaPierre was listening in to WHEC at the moment that the summons was broadcast is probably less than a million to one.

AN INDICATION of the volume of traffic handled by naval radio telegraph stations is given by the announcement that the naval station at San Francisco sent 159,417 words during the month of June, that at Honolulu, 147,131 and Washington, D. C. 134,737 words.

DR. ALFRED N. GOLDSMITH (New York; Chief Broadcast Engineer, Radio Corporation of America): "This is the fourth summer of broadcasting and it is not stretching the truth to say that broadcasting has finally evolved from a seasonal amusement to an all-year-round service that brings entertainment, enlightment, and education day in and day out, to the American public.

The radio devotee, during the long indoor season, has grown to know the radio personalities that have come week after week into the home. The sponsored programs, ensuring the periodic appearance of certain radio features, have taken firm grip in the radio audience. The friendly contacts thus established are not to be broken off even though summertime may usher in a new order of things. The public must have its radio program just as it must have its daily newspapers —in summer as well as in winter."

S. W. SMITS, listening in at East Transvaal, South Africa, heard the tiny peep of a short-wave radio station, one night last April. Half way round the world, members of the Wilkins Expedition, mushing their way from Fairbanks to Point Barrow, had stopped to camp for the night. The radio operator had set up his little portable B battery powered transmitter, in order to report the day's progress to expedition headquarters at Fairbanks and Point Barrow, not more than 250 miles distant. In spite of minute power and distance, Mr. Smits overheard the little transmitter at the ether end of the world.

SAM PICKARD
Washington, D. C.

Chief of Radio, United States Department of Agriculture:

"The farm fan has two chief criticisms of radio. The one most often voiced is the curse of not getting enough sleep. Most of them admit that they sit up late at night with their sets. Many others say that while they like to be neighborly they tire of the whole community dropping in every winter evening and then forgetting to go home. . . . Radio on the farm is yielding more dollars and cents return on the investment, developing a more prosperous American agriculture, and bringing about a better contented, understanding class of farmers than any other single scientific contribution of the age."

AMERICAN radio exports in May, 1926, were $443,981 as compared with $577,710 in May 1925.

WGY'S programs sent out on a frequency of 9140 kc. (32.79 meters) through station 2 XAF are frequently used for rebroadcasting purposes by the British Broadcasting Company. When especially good conditions prevail, the British report that these programs are equal in quality, if not better, than the transmission of some of their own local dance orchestras.

A RECENT Argentine decree places a limit upon the amount of advertising and mechanical music which a station may broadcast, says a consular report.

ALTHOUGH the number of examiners handling radio applications in the Patent Office has been almost tripled, there are 1850 patents pending as compared with 1594 on January first. The radio division is five months behind in its applications.

How to Build the "Equamatic" Five-Tube Receiver

RADIO BROADCAST Photograph

A FRONT VIEW OF THE COMPLETED FIVE-TUBE RECEIVER

The neat layout of the controls is by no means the least important of the "Equamatic's" features. The three condenser dials tune with remarkably consistent correlation

An Efficient Tuned R. F. Receiver Employing a System for Automatically Varying Transformer Coupling with Frequency—Obtaining the Optimum Practicable Energy Transfer at All Frequencies

By ZEH BOUCK

IN THE September RADIO BROADCAST, we discussed the semi-theoretical aspects of the King Equamatic coupling system as applied in general to radio circuits.

In recapitulation, the Equamatic arrangement is a method of varying the coupling between two circuits automatically as the set is tuned, in order that the optimum value of power transfer between the circuits may be maintained at all frequencies. It was demonstrated that this consistent optimum transfer can never be achieved with fixed coupling; and that the efficiency —or, more correctly, the sensitivity and selectivity—of any receiver can be raised by the application of Equamatic tuning.

The automatic variation in coupling is secured by mounting the primary coil on the extended shaft of the tuning variable condenser, the eccentric position of the secondary being adjusted and fixed at best position. The degree of maximum coupling is adjusted by changing the position of the stationary secondary coil in relation to the moving primary, while the acceleration, or degree of coupling change, is determined by the angle of eccentricity.

It has been noted that the Equamatic system can be applied to practically any receiving circuit. However, its practical aspects and advantages are probably most easily demonstrated in a familiar circuit, and the writer has chosen for this purpose a variation of the two-stage tuned r.f. receiver (the almost standardized five-tube set).

The comprehensive idea is best illustrated by reference to the schematic diagram, Fig. 1. Coils L_1, L_2, L_3, L_4, L_5, and L_6 are alternately primaries and secondaries of first stage r.f., second stage r.f., and detector circuits. Condensers C_1, C_2, and C_3 are 370-micro-microfarad tuning condensers across the secondaries. This arrangement will be recognized as the standard tuned r.f. circuit. The Equamatic innovation lies in the automatic coupling variations between the primaries and secondaries, L_1, and L_2, L_3 and L_4, L_5 and L_6.

The primary, L_1, is mounted on the shaft of the tuning condenser C_1. Similarly, L_3 is mounted on the extended shaft of C_2, and L_5 on the shaft of C_3. As the dials are turned, the coupling between the primaries and secondaries is varied with an acceleration depending upon the angle of mounting. As already mentioned, this angle is adjusted so as to meet the particular requirements of the circuit and tubes, automatically maintaining the optimum energy transfer over the entire tuning range.

COIL DATA

AS WILL be seen in Fig. 2, the primaries are wound with fourteen turns of No. 24 wire on a 2-inch form, and the secondaries with 60 turns, of the same size wire, on 2½-inch forms. It will be observed that relatively large primaries are made possible in the Equamatic arrangement, insuring adequate transfer of energy on the low frequencies (long waves). Karas condensers are provided with special extension shafts suitable for the mounting of the primaries.

While, due to the Equamatic principle, the circuit is inherently a stable one, the small retard coils, X_1 and X_2, are included in the grid returns to render the adjustment of the coils and the operation of the receiver less critical. About 40 turns of No. 36 wire on an iron core having a cross section of one quarter square inch will be about right. The value is not critical.

While the home construction of the coils and retard chokes presents no very great difficulties, inductors and chokes especially designed for operation in Equamatic receivers can be purchased ready made.

The remainder of the circuit presents no unconventional feature, mechanically or electrically. Condenser C_4 is the usual 0.00025-mfd, grid condenser shunted by a two-megohm leak, R_1. C_5 is a 0.0025-mfd. bypass condenser across the primary of the first audio frequency amplifying transformer, while C_6 is a 1.0-mfd. bypass across the radio frequency plate supply.

R_2 is a ten-ohm rheostat controlling the r.f. filament, and R_3 a twenty-ohm rheostat for the detector tube. The filaments of the audio-frequency amplifier tubes are lighted through ¼-ampere Amperites, R_4 and R_5. P. G. B, and F refer, of course, to the initialling on the audio frequency transformers.

The Facts About This Receiver

Type of Circuit	Tuned radio frequency.
Number of tubes.	Five. Two stages of r. f. with 201-A tubes; detector, using 201-A or special detector tube; first audio stage, 201-A; second audio stage, 112 or other semi-power tube.
Features	Maximum r. f. gain obtained by use of special automatic variable coupling arrangement.
Frequency range	1500 kc. to 500 kc. (200-600 meters).

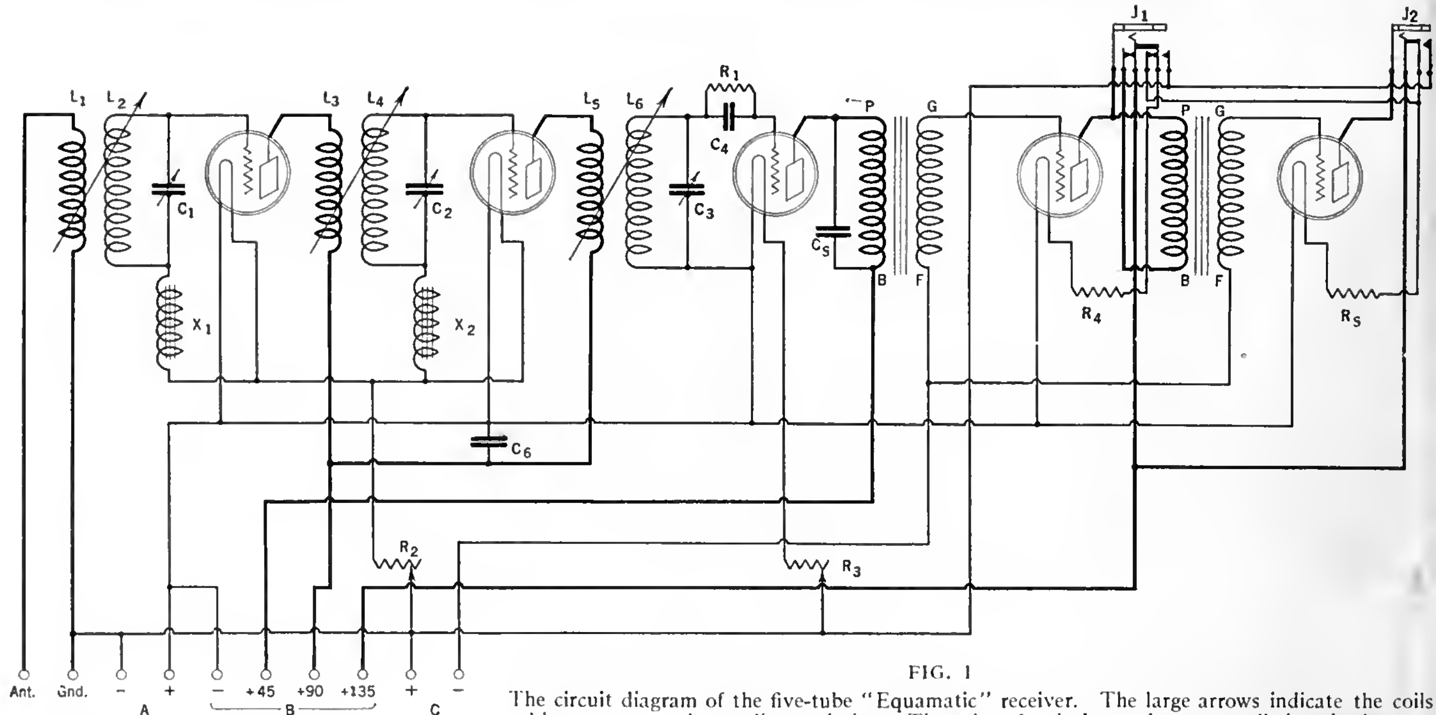


FIG. 1

The circuit diagram of the five-tube "Equamatic" receiver. The large arrows indicate the coils subject to automatic coupling variation. The values for the lettered parts are all given in the text: X_1 and X_2 are retard coils included in the grid returns to render the adjustment of the coils and the operation of the receiver less critical

J_1 and J_2 are respectively first stage and second stage filament control jacks. If desired, for simplicity, the filament control feature can be eliminated.

The following is a list of the exact parts used in the receiver described:

3 Karas Equamatic R. F. Transformers	12.00
3 Karas Orthometric 17-plate 0.00037—mfd, Extended Shaft Condensers	21.00
3 Karas Micrometric Vernier Dials	10.50
2 Karas Harmonik Audio Transformers	14.00
2 Karas Equamatic Retard Coils	2.00
1 Yaxley 10-ohm Rheostat with Gold Dial	1.50
1 Yaxley 20-ohm Rheostat with Gold Dial	1.50
1 Yaxley Gold Interstage Phone Jack	1.05
1 Yaxley Gold Open-Circuit Phone Jack	.75
1 Yaxley Gold Filament Switch	.75
1 Sangamo 0.00025 Fixed Grid Condenser with Clips	.50
1 Amsco 2-Megohm Grid Gate	.45
2 1-A type Amperite 6-Volt Resistors with Mountings	2.20
1 Burgess 4½-volt C Battery	.60
1 Jones Multiplug with Mounting and 8 ft. of Cable	4.50
5 Benjamin UX Cushion Sockets	3.75
1 Electrad 0.0025-Mfd. Fixed Condenser	.40
1 Electrad 1-mfd. Bypass Condenser	.90
1 Formica 7" x 28" Drilled and Engraved panel	6.80
1 Formica 6" x 27" Drilled and Engraved Sub-panel	4.69
3 Karas Sub-Panel Brackets	.70
2 Amsco Binding Posts	.20
Binding Posts, Screws, Spaghetti, Bus Bar, Lugs, etc.	1.00
Total	$89.79

The above list is given for the benefit of the fan who may wish to construct an Equamatic receiver exactly similar to that described in this article, but there is no reason why substitutions equivalent electrically and mechanically may not be made for any of the parts listed.

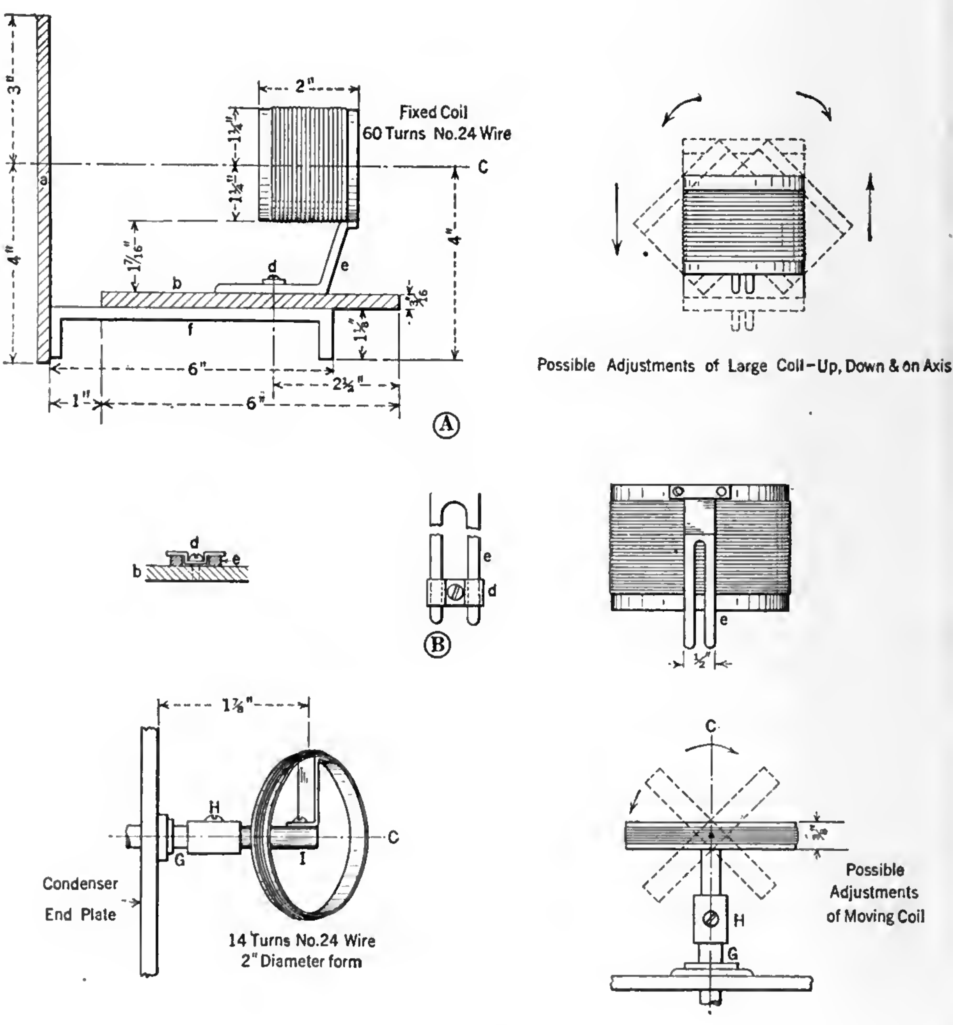


FIG. 2

It is not difficult for the home constructor to make his own coils for the "Equamatic" receiver, and the necessary details are given above. Reference to this diagram begins in column, 2, page 479. Data on this system helpful to the home constructor appeared in last month's RADIO BROADCAST

CONSTRUCTIONAL DETAILS

THE constructional details of the Equamatic receiver are suggested in the panel and sub-panel layouts, Figs. 3 and 4 respectively, and in the photographic illustrations. If preferred, a baseboard may be substituted for the sub-panel, striking out four dollars from the complete cost.

Drilled and engraved panels specially designed for the Equamatic receiver are now obtainable. However, the experienced fan is quite capable of working out his own layouts and panels. In such a case, special care need be taken only to insure the perfect alignment of coils and condensers. The stationary or secondary coils should be so mounted that, should they be turned perpendicular to the panel, the axis of the condenser coincides with the axis of the coil. This precaution is important.

The mechanics of securing this arrangement are illustrated in Fig 2. Drawing A shows the dimensional characteristics of the stationary coil mounting. The front panel is designed by a, the sub-panel by b; c, in all drawings, is a line passing through the center of the condenser shaft; d is a machine screw with a square washer holding the coil bracket, e, to the sub-panel; f is a bracket of ⅛″ brass strip, 6″ long, holding the sub-panel to the control panel. Drawing B continues the details of the coil bracket, e, and the manner in which it slides through the swivel screw and washer d, on the sub-panel, b.

Drawing c suggests the moving or primary coil arrangement. A brass sleeve is fastened to the extended shaft, G, of the condenser by set screw H. A bakelite or hard rubber strip extends from the brass sleeve, to which the primary is mounted by a simple "L" bracket. The coil has been turned slightly to show this idea.

Photographs of several home-made mountings will be found in the preceding article which appeared on page 377-79 of the September, 1926, RADIO BROADCAST.

The holes for the condensers, brackets e, and swivels d, are drilled according to the panel and sub-panel layouts.

The mechanics of mounting the coils are made clear by reference to Fig. 5. The reader interested in the mechanical construction of home-made mountings is referred to the preceding article, and to the data given in Fig. 2 of this article. The small "pillboxes" to the right of the two right-hand tubes are the retard coils.

While binding posts are suggested in the wiring diagram for the sake of clarity, a Jones Multiplug has been used for all connections to the receiver, with the exception of the C battery.

Figs. 4 and 8 suggest an efficient sub-panel or base-board layout. As will be observed, all coils are connected to associated apparatus by flexible leads. It is important that the inductor terminals be wired correctly in respect to outer and inner turns. Assume both coils in a perpendicular position to the panel, *i.e.*, the position in which there would be no coupling change as the circuits are tuned. The two coils will necessarily be parallel. Viewed from the front of the panel, the lead nearest to the observer should be connected to the antenna, in the case of the first primary, and to the plates of the preceding tubes, in cases of the second and third primaries. The secondary lead, nearer to the panel, is led to the negative filament in the first two tubes and to plus filament in the detector tube.

Fig. 6 shows the under-sub-panel wiring, while the photograph at the top of the first page of this article is a front view of the finished set.

ADJUSTING THE COIL ANGLE

THE second and third coils are always adjusted so that coupling is loosened as the frequency increases (as the wave goes down). As a rule, the first coils are similarly adjusted, though unusual antenna conditions, as will be noted later, occasionally reverse this last motion.

The stationary coils should first be placed at slightly above the correct angle, which is in the neighborhood of 58 degrees measured between a side of the coil and the front panel. On the special Karas Equamatic sub-panels, this angle is marked with a white line. A glance at Fig. 8 will convey a close idea of the correct (final) position. All three condensers are now turned to maximum capacity, and the extension shafts adjusted (by means of the set screw) so that each primary can be turned (on a vertical axis) parallel to the secondary. When this is done, we shall have close coupling between primaries and secondaries. In other words, the primary coils will form the same angle with the front panel, as the secondaries.

In this position, coupling between primaries and secondaries can be tightened by pushing the secondary coil, in its slide mounting, closer to the primary. Coupling can be loosened by reversing the process.

All adjustments of coupling and angle are made in this position, *i.e.*, with the primaries and secondaries parallel—and with the receiver connected to antenna and batteries.

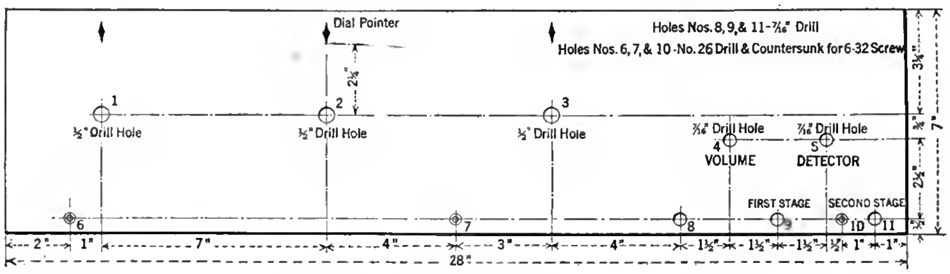
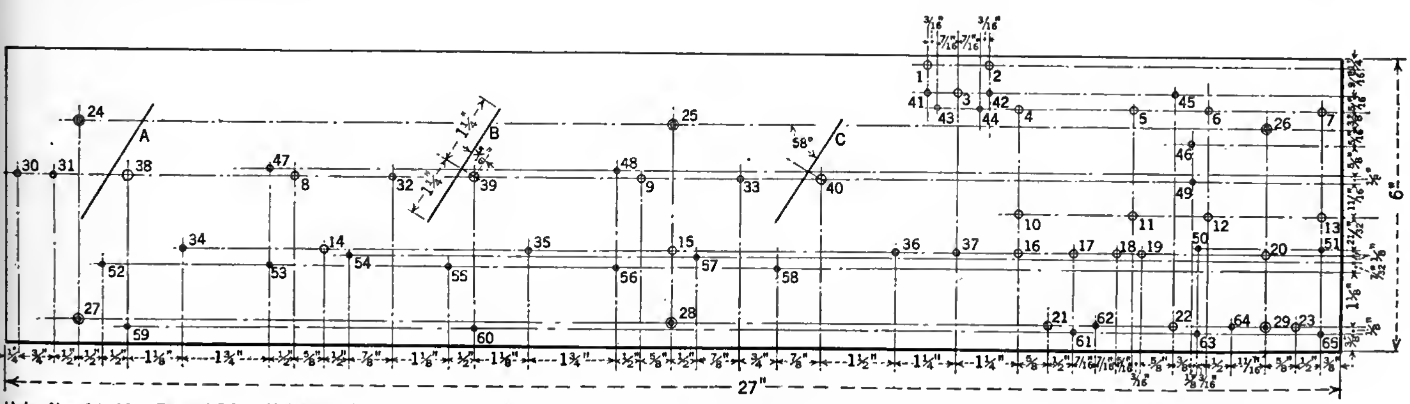


FIG. 3

This diagram shows the main panel layout for the benefit of those constructors who will build the five-tube receiver with the parts as listed by the author on page 480



Holes Nos. 1 to 23 — Tapped 6-32. Holes Nos. 24 to 29—No. 26 Drill & Countersunk for 6-32 Screw. Holes Nos. 30 to 37—No. 26 Drill. Holes Nos. 38 to 40—Tapped 8-32. Holes Nos. 41 to 65—No. 42 Drill. Lines A, B, & C Show Mounting Angle for Coils.

FIG. 4

The sub-panel layout which the author used. If desired, a base-board may be substituted for this panel. On the special panels which are now obtainable for this receiver, the correct angle for the stationary coils is marked clearly with a white line

FIG. 5
A behind-the-panel view of the author's receiver, which clearly shows the general arrangement of the coils. The stationary coils may be adjusted in the first case by virtue of the fact that a swivel arrangement, as shown in Fig. 2, is employed

If the coupling between primaries and secondaries is increased beyond certain limits (if the secondary is pushed too far over the primary) the system will become unstable and will oscillate at about 5.2 volts on the filaments (with the rheostats three quarters out). Coupling should be loosened until the circuit is stable at this filament potential. As the coil angle in this first position is purposely high, it will probably be found that, with each condenser tuned to the shortest possible wave, the circuit will again oscillate. The coils are then turned up to close coupling, the angle slightly decreased (the coils turned in toward the panel), and returned to the short-wave position. If the circuit still oscillates, the angle is further decreased (the adjustment being changed always at maximum coupling) until the circuit is stable over the entire tuning range.

REVERSED COUPLING ON THE FIRST TUBE

As PREVIOUSLY mentioned, it is occasionally possible that the receiver will function better with a reversed coupling action between the antenna primary and the first secondary, *i.e.*, with the coupling *increasing* as the wavelength is decreased.

There are two antenna conditions, as well as several other interactions, which will determine the direction of coupling movement in this circuit. Whenever two coils are brought close together (the coupling increased) the inductance of these coils is lowered; in other words, they are tuned to a shorter wavelength. This is a simple transformer action. Therefore, when a very short antenna is used, in the average case we will secure best results with loose coupling on the short wavelengths and tight coupling on the long wavelengths (the normal arrangement, Fig. 8). The loose coupling will raise the resonance point of the antenna circuit to something approaching the wavelength of the tuned station, with a resulting amplified signal. On the longer waves, close coupling will be necessary to secure adequate transfer of energy. However, with an exceptionally long antenna, close coupling on the shorter waves will be desirable in order to lower the inductance of the open circuit. In this latter case, the order of coupling variation will be reversed. Under which of the two possible conditions your receiver works best is easily determined by experiment. To make the coupling loosen as the wavelength increases, it is merely necessary to set the two coils parallel when the condenser is at its lowest capacity. Dependent to a certain degree on the angle of the first coil is the selectivity, while the angles of the other two coils affect stability.

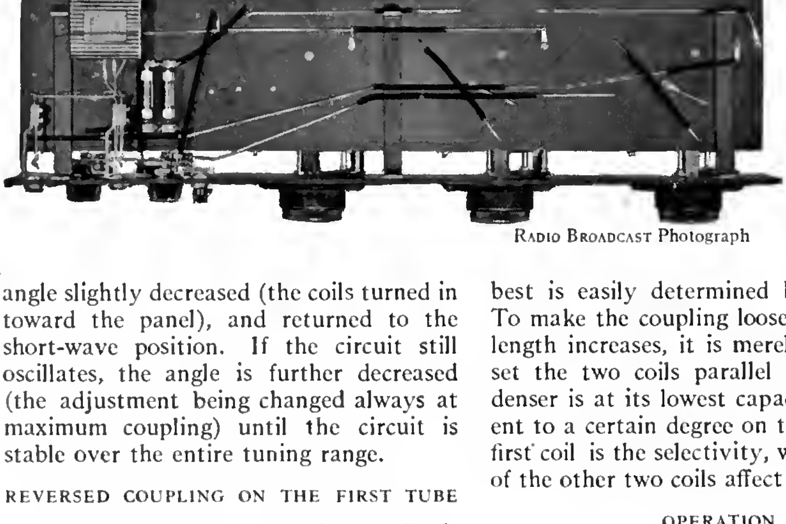


FIG. 6
There's very little to see from underneath the sub-panel except the filament wiring and the grid battery, etc.

OPERATION

ASIDE from the adjustment of the coils, the operation of the Equamatic five-tube receiver is identically the same as that of any similar set, such as the conventional neutrodyne. Practically all tubes can be used in this set with the proper A, B, and C voltages. For the indicated potentials, five 201-A type tubes are recommended. If desired, a type 171 tube may be employed in the output socket with increased quality and volume. In this case, a half-ampere Amperite should be used in the filament circuit of the 171 tube, and a separate C battery, of the correct potential, interpolated in the grid return.

The Equamatic receiver tunes with delightful ease, maintaining a remarkably consistent correlation among the three dials over the entire tuning range. The accompanying tuning chart, Fig. 7, will be found reliable on all sets built with the designated parts. Selectivity is perfect, without the knife-edge tuning that causes marked distortion on the short waves, or the broad tuning on the longer waves which characterize the conventional tuned r. f. receiver.

In comparison with a standard neutralized, five-tube tuned radio frequency receiver used in the writer's laboratory, the Equamatic receiver described shows a distinct superiority, particularly on the longer wavelengths.

Articles shortly to follow will describe the application of the Equamatic system to other widely used circuits.

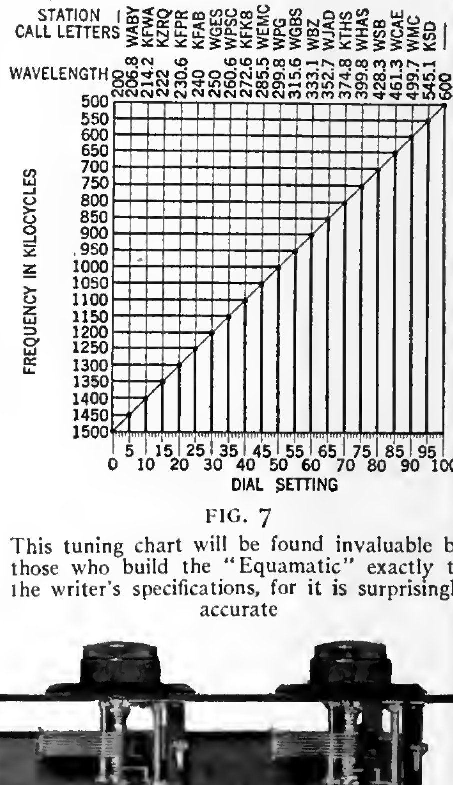


FIG. 7
This tuning chart will be found invaluable by those who build the "Equamatic" exactly to the writer's specifications, for it is surprisingly accurate

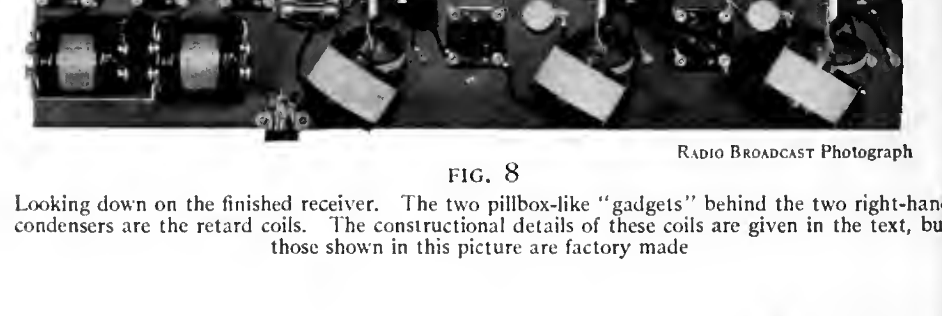
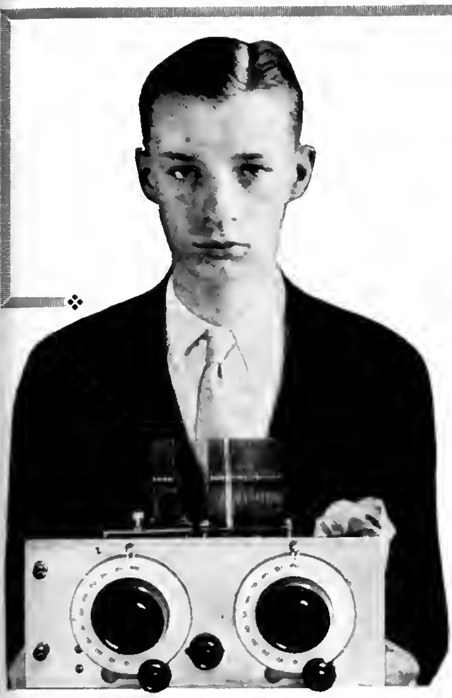


FIG. 8
Looking down on the finished receiver. The two pillbox-like "gadgets" behind the two right-hand condensers are the retard coils. The constructional details of these coils are given in the text, but those shown in this picture are factory made

Radio with the

Dyott Brazil Expedition

The Laboratory of Radio Broadcast Has Supplied Short-Wave Equipment to Three Famous Expeditions, that of Commander Dyott to the "River of Doubt" Being the Most Recent



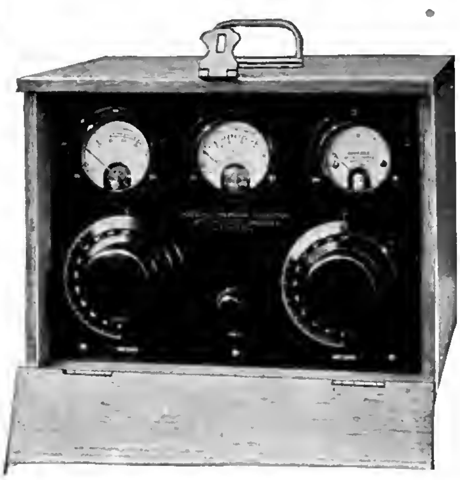
ARTHUR PERKINS (2 APQ)
Who goes with Commander Dyott to the River of Doubt to report by means of a battery operated short-wave transmitter the progress of the expedition. The receiver that will be used by Mr. Perkins is shown in this picture

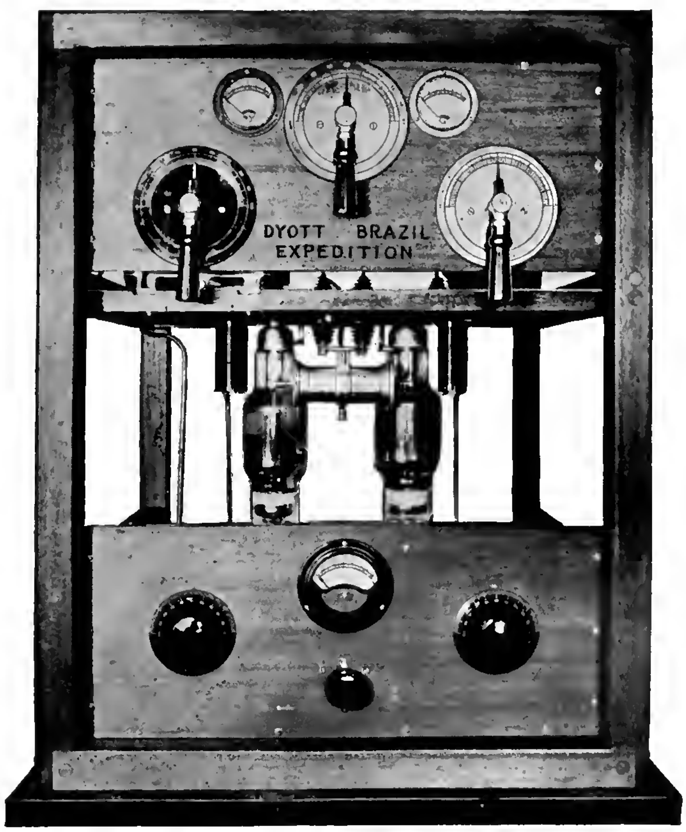
WITH the departure of Commander Dyott, of the Roosevelt Memorial Association Expedition, for the River of Doubt, in Brazil, RADIO BROADCAST adds another name to its list of those expeditions which are equipped with short-wave apparatus constructed according to specifications supplied by the Laboratory at Garden City. As generally chronicled in the press, it was on July 24th that the Dyott expedition left New York on its big adventure—to re-explore the River of Doubt, up which Theodore Roosevelt laboriously navigated in 1914, before short-wave radio communication, as it is known to-day, was dreamed of. With Dyott went two complete radio transmitters, a 250-watt short-wave transmitter built for RADIO BROADCAST by the Allan D. Cardwell Corporation, and a small portable set operating from Eveready B batteries. It is intended that the 250-watter, together with a suitable receiver (which was especially built for RADIO BROADCAST), be set up as a base station in a suitably located spot somewhere near the center of Brazil. This station will be under the charge of Eugene Bussey (2 CIL), of Yonkers, while the key of the small portable set, which will advance up the river with the expedition, will be "pounded" by Mr. Arthur Perkins (2 APQ). The equipment used by Mr. Perkins was built by himself to RADIO BROADCAST specifications, with Hammarlund parts.

At the time of writing, little can be told about schedules and wavelengths, as this depends upon restrictions imposed by the Brazilian government. It is probable, however, that the 7500-kc. band (40-meter band) will be used. The call signals, too, are not yet known, but an endeavor is being made to obtain the use of the calls GMD and 2 GYA for the base station and advance station respectively.

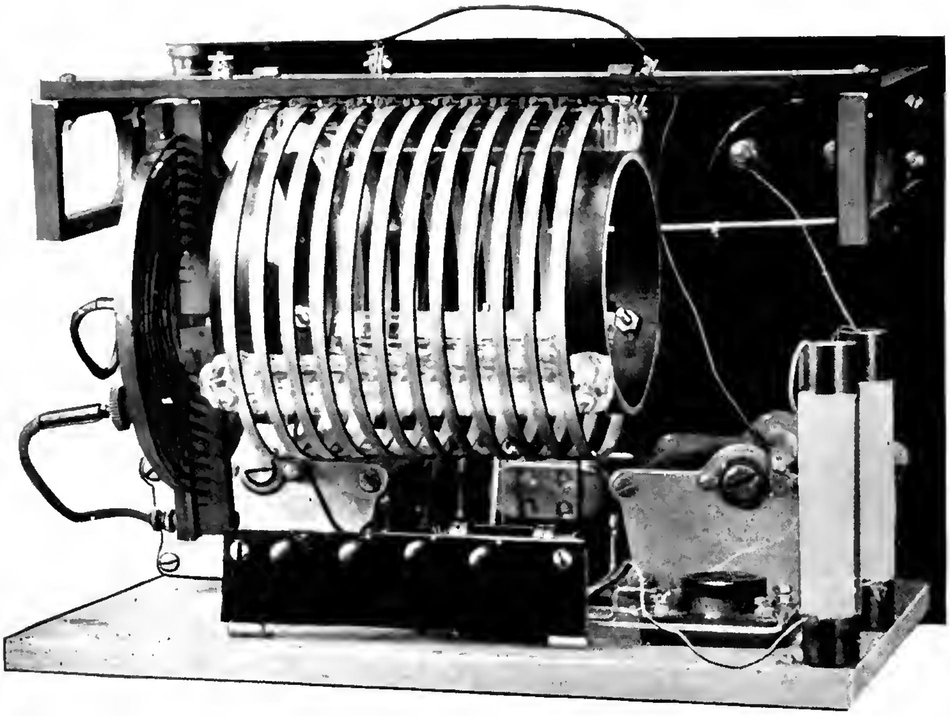
Other expeditions which have been equipped with RADIO BROADCAST apparatus are those of Francis Gow Smith and of Commander MacMillan. Gow Smith sailed many months ago for the wilds of Brazil, seeking more information for the museum of the American Indian. He appealed to 2 GY (the experimental station of RADIO BROADCAST) for a receiver so that he would be able to receive the short-wave transmissions of WGY and KDKA while he was in the jungles. We have since heard from this famous explorer that he has been singularly successful in his efforts to listen to the short-wave broadcasts from the outer world and, thanks to the coöperation of the General Electric Company in sending out special time signals, he has regularly been able to ascertain his geographical positions very accurately.

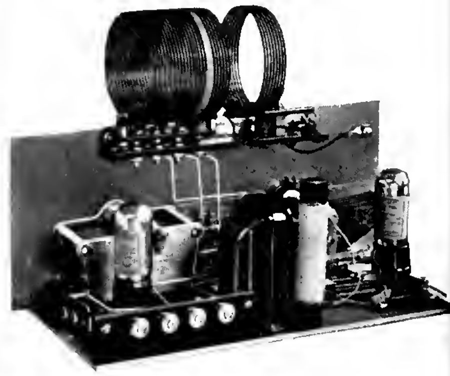
On June 29th, Commander MacMillan sailed for Greenland with two vessels, his own *Bowdoin* and a new schooner, the *Sachem*, built by Rowe Metcalf. On the latter vessel, as radio operator, is Austin C. Cooley who described in RADIO BROADCAST some time ago his experiments in picture transmission by radio. Up to the present time 2 GY has maintained nightly communication with KGBB, the *Sachem*, although she is, as we write these words, in the region of continuous daylight off Greenland. The receiver used by Mr. Cooley was built by the operators at 2 GY. It is similar to the Silver-Marshall set used at the base station of the Dyott Expedition.





TRANSMITTERS
Which will play an important part during the expedition up the River of Doubt. The small transmitter shown above was built by Mr. Perkins, and will accompany him up the river so that he will be in touch with the base station. To the right is shown the 250-watt transmitter built by Cardwell which will be used to communicate with the outside world from the base station, and with Mr. Perkins up the river





THE ADVANCE SET

An interior view of the receiver which will accompany the expedition up the River of Doubt

ABOVE

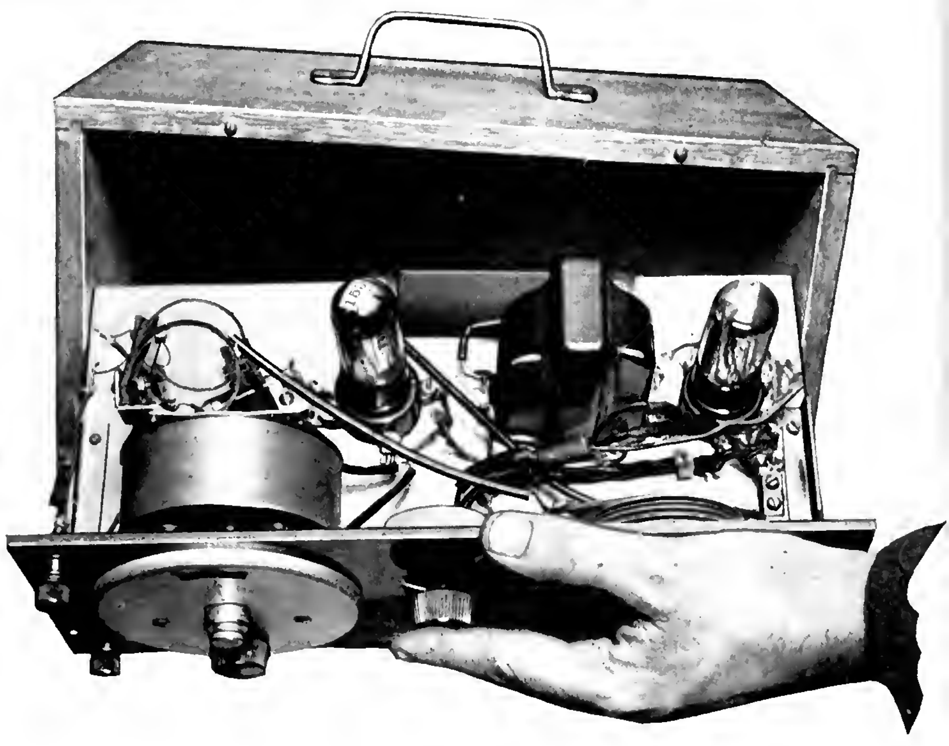
Is shown an interior view of the short-wave portable transmitter which will accompany the expedition up the River of Doubt, and will be operated by Arthur Perkins. Amateurs will recognize the standard short-wave equipment that went into this set. The call 2 GYA may be allotted to this transmitter but definite information concerning this matter is not yet available

TO THE LEFT

May be seen the short-wave receiver built for RADIO BROADCAST by Silver Marshall to be utilized at the base station of the Dyott expedition. *Below:* The short-wave receiver built by RADIO BROADCAST for Mr. Gow Smith an explorer now in the very depths of South America. With this receiver he has heard, from the center of Brazil, concerts from WGY and KDKA, and also from London

AT THE BASE STATION

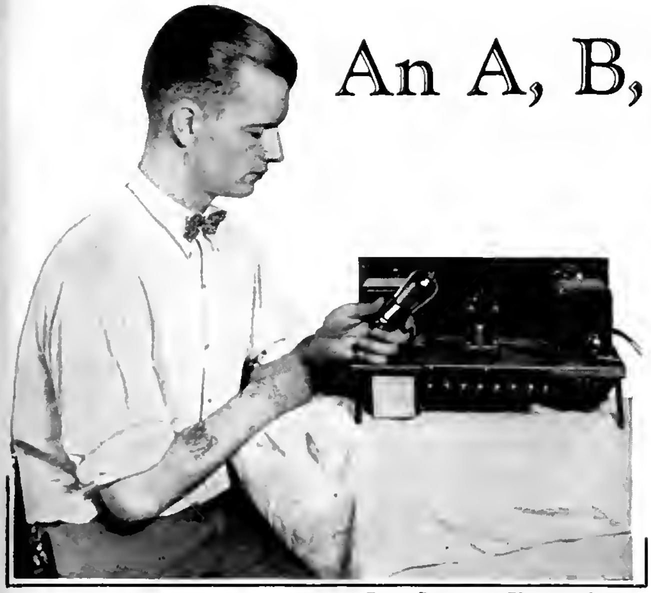
The receiver below will be depended upon for reception of signals from Mr. Perkins and the outside world. This is the rear view of the set built by Silver-Marshall, shown above



An A, B, C Line Supply Device

A Suitable Unit Which Makes Complete the Elimination of Batteries from the Receiver—A Comparison Between the Costs of A Supply Sources—Adapting the Unit to the Receiver—The New Raytheon Tube

By B. F. ROLAND



Radio Broadcast Photograph

FIG. 1

A rear view of the A, B, C, line supply device shows the simplicity of construction. The operator is examining the new 85-milliampere Raytheon rectifier tube, the key element to the entire device

RADIO manufacturers everywhere are bending the energies and resources of their development laboratories to an adequate solution of the problem of utilizing the a. c. home supply for radio purposes. It is fairly certain that manufacturers who will place on the market reliable and satisfactory a. c. operated receivers at reasonable prices will enjoy a tremendous sale of these devices. The time is here, if ever, for the presentation of the "light-socket" receiver.

The reasons for the sudden growth of this demand are not obscure. Radio has gradually passed from the experimental stage, in its major aspects, into a state of mature development, requiring the skill and efficiency of trained engineers. The average broadcast listener of today wants reliable performance, high quality reproduction, and ease of control. The keynote of all these virtues is *power*. What better source of power is there than the a. c. light-socket, at an average rate of not more than ten cents per kilowatt hour? Additional advantages offered by the use of a. c. power on radio receivers are the increased reliability, simplicity of maintenance, and ease of control.

Several fundamental differences exist among the various methods in development and in use at the present time, and a brief survey of their respective features will give the reader a perspective of the situation, whereby he can decide for himself the proper method to use in his own radio installation. In the present article, a method will be described in detail for constructing an a. c. operated set at home, using standard parts. The photograph, Fig. 1, shows a power unit designed to supply A, B, and C voltage for receivers employing from three to nine tubes.

Without doubt, the first method employed for operating a radio receiver from a. c. power is that shown in Fig. 2, on the next page. In this circuit, the radio-frequency amplifier tubes, and audio amplifier tubes, are supplied with "raw" a. c. on the filaments. The grid and plate are kept at an average zero potential from the a. c. filaments by means of potentiometers, which are carefully adjusted to reduce a. c. hum to a minimum. The detector may be a crystal detector as shown, or it may be replaced by a tube detector, operated from a small dry cell. This tube may be supplied by a separate d. c. filament source, or its energy may come from the plate of the power amplifier tube by placing the filament of this detector in series with the B supply of the power amplifier, as is done in some models appearing on the market this season. Obviously in this case, the detector tube must have a filament requiring not more than the 65 milliamperes current which the plate circuit of the power amplifier can supply. This method of supplying a radio set with a. c. power is very good if it can be properly balanced, but in the hands of any but an expert, it is very hard to eliminate all the hum caused by the a. c. field surrounding the filament leads. If, when using the "raw" a. c., one-volt oxide coated filament tubes are employed, such as the WD-11, WD-12, or Western Electric N type, much better results can be obtained than by the use of standard 201-A type tubes. This was suggested to the writer by Keith Henney of Radio Broadcast Laboratory. In either case, the potentiometers must be readjusted every time the filament temperature is changed. If a toy transformer is rewound to have a center tap accurately placed it may be used instead of the potentiometer.

One modern receiver on the market now employs a method similar to that shown in Fig. 2, using UX-112 tubes for all amplifier stages. Western Electric 216-A or VT-2 tubes will be found to give equally good results. In any arrangement of this type, the last stage audio tube is a power amplifier connected in the usual manner. Proper C batteries must be employed in the various stages to make sure the amplifiers are operating on the straight portion of their characteristic, thus assisting to eliminate the possibility of a. c. hum. The B battery potentials of the receiver in Fig. 2 are obtained from customary sources.

THIS article describes an easily built device which will supply A, B, and C potential in sufficient quantity for a receiver using up to eight or nine tubes. This supply device, as designed and described here, is applicable for filament supply only with such sets as use the 199 type tubes—connected in series. That means that if this unit is to be used with an existing receiver, the filament circuit must be rewired as directed in these pages and only three-volt tubes can be used. This device will supply: 6 volts a.c. for lighting the filaments of power amplifier tubes, up to 50 volts C potential, up to 200 volts of B potential, and will supply up to 60 mils. of filament current to as many as 9 three-volt tubes in series. Although the unit described here requires the rewiring of the filament circuits to a series connection, this unit should please many radio constructors who are anxious to have a really dependable source of current supply for their sets. This article will serve to introduce the new type BH Raytheon tube whose sphere of usefulness is much larger than the old type B. No critical adjustments are necessary with this unit when the a.c. line voltage changes, and no parts are listed which are not easily had. This model has the approval of the Laboratory of the Raytheon Company and also of Radio Broadcast *Laboratory.* —The Editor.

TYPES AND COST OF A POWER SUPPLY

ANOTHER method of supplying A power to radio receivers is by means of the storage battery and "silent" or "trickle" charger. In this arrangement, advantage is taken of the smoothing properties of a storage battery to filter out the ripple in the pulsating d.c. obtained from the battery charger. There are two general types of this class of service, depending upon the choice of rectifiers. The first is the electrolytic, which includes either lead-aluminum cells with borax or ammonium phosphate electrolyte, or the tantalum-lead cell with sulphuric acid as an electrolyte. The normal charging rate of these rectifiers is from 0.25 to 0.50 amperes at 6 volts, and if the trickle charger is operated 24 hours a day, the energy consumed by the average five- or six-tube receiver will just about equal that delivered by the trickle charger. The cost of energy obtained in this manner is approximately seventy cents per kilowatt hour at the receiver, assuming an overall efficiency of 15 per cent. The second type of A power supply in this class contains a gaseous discharge type of rectifier, and is capable of supplying d.c. to a storage battery up to 2 amperes. On account of the power required to heat the rectifier filaments, the overall efficiency seldom exceeds 8 per cent., and the average cost of power in this instance is approximately $4.00 per kilowatt hour, including fixed charges and replacement costs on the charger, rectifier, and storage battery. The trickle charger method is probably the most satisfactory plan developed at the present time for the supply of separate A battery power from the light socket. It is economical, reliable, and does not impair the quality of reproduction by a. c. hum as is often the case in supplying raw a. c. to the filaments. The main objection to its universal adoption is the use of the storage battery which often gives off corrosive vapors and needs frequent attention for proper performance.

Neither of the foregoing methods closely follows the general principles of the modern and efficient B-power supply, employing transformer, rectifier, and filter. When the values of current and voltage are considered with reference to A-battery filter circuits, it is not surprising that there has not yet been developed a commercial A power supply along these lines. Dr. Vannevar Bush said at the last Radio Manufacturers Association Convention: "For every microfarad required to produce a certain degree of smoothing at 60 volts, there are required 1000 microfarads for the same degree of smoothing of the same power at 6 volts." The physical dimensions of A filter circuits are, therefore, beyond the scope of economic design. Fairly satisfactory A filters have been built along the lines shown by Fig. 3. Here the customary filter condensers are replaced by resistances. The chokes occupy the usual series position, serving to divert the a. c. through the shunt resistances while allowing the greater part of the d. c. to pass on to the radio receivers. The filtering efficiency of this type of circuit is good if enough current is allowed to pass through the resistances. This current usually attains a value of approximately 30 per cent. of the output current and hence it imposes a large load on the rectifier that does not serve any useful purpose. The overall efficiency of a 6-volt 1.5-ampere device of this type was measured and found to be 6 per cent., making the cost of A power at the receiver approximately $2.75 per kilowatt hour by this means.

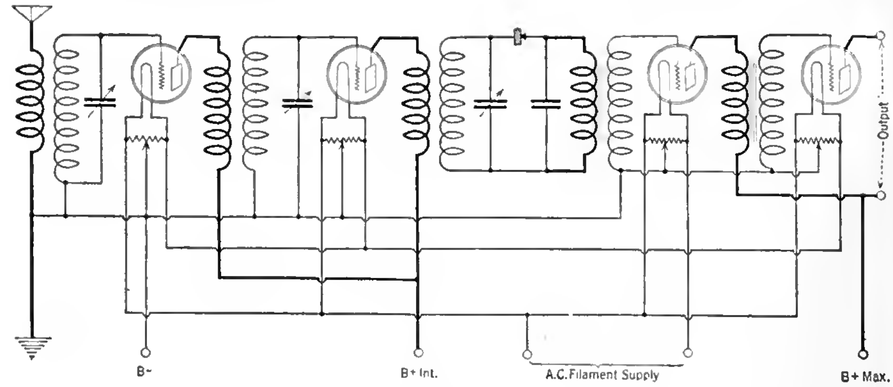


FIG. 2

A four-tube circuit which utilizes merely the stepped-down a.c. for energizing the filaments of the tubes. Since, where a crystal detector is used, the raw a.c. may be applied to the amplifier tubes, there is no need for rectifier or filter

FILAMENTS IN SERIES

A LOGICAL solution to the difficulties of A power filtering is to connect the filaments of the radio tubes in series. Under this condition there are higher voltages available, making it possible to use condensers to advantage, and the current consumed is so small that the filter choke coils are of reasonable proportions.

In Fig. 4 will be found a schematic diagram of the power unit illustrated in Fig. 1. This device will supply voltages and currents as follows:

A Battery—60 milliamperes—6 to 30 volts.

B Battery—up to 25 milliamperes at {200 volts, 90 (variable) volts, 45 (variable) volts}

C Battery—From 0 to 50 volts.

The use of the device is, of course, restricted to radio receivers employing tubes similar in characteristics to the UX-199 or DV-3 tubes with filaments wired in series, and under these conditions its performance as a universal power supply is ideal. The device illustrated is adaptable to any type of radio circuit and has been used with success on a three-circuit regenerative set, the Browning Drake, and tuned radio frequency receivers, with variations of each type. Transformer- resistance- or impedance-coupled amplifiers have been employed indiscriminately with equally good success.

In Fig. 4, T_1 is the General Radio power transformer designed for 50 watts, 110 volts, at full load. The high voltage secondary provides 350 volts each side of the tap at the center at no load. The third winding, T_2, provides 5 volts at 5 amperes for the "raw" a. c. filament supply of an UX-112 or UX-171 power-amplifier tube. This may be supplied by a separate filament lighting transformer. In this construction, a Brach unit serves the purpose nicely. Across each half of the secondary of T_1 is connected a 0.10-microfarad buffer condenser, c_1, and c_2, of the 1000-volt flash test type. The outer ends of this winding are connected to the filament terminals of a

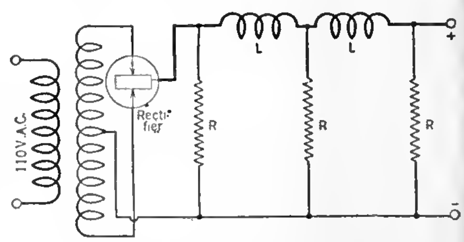


FIG. 3

Line supply devices may employ several systems of filtering the rectified a.c. Here is shown one using resistances instead of bulky bypass condensers

standard UX type socket, into which is plugged the new type BH Raytheon rectifier, Ra. The plate terminal of the socket, corresponding to the cathode of the Raytheon tube, is connected to the plus side of the filter circuit.

The filter circuit of this power unit includes choke coils, L, capable of passing 85 milliamperes direct current without heating, and having a residual inductance of at least 25 henries per choke at this value of direct current. The General Radio type 366 standard B-substitute choke is admirably suited for this service. Others which fulfill the above requirements will probably be equally satisfactory. The filter condensers are arranged in order as shown in Fig. 4.

The voltage-control unit shown at the right-hand end of Fig. 4 has been tried under all conditions, and has given good service. There was some difficulty in obtaining proper values and current-carrying capacities of the various resistors and, after considerable testing, the units specified were adopted. All of the parts in the control unit may be obtained from regular stock of the various manufacturers or their dealers.

For the plate voltage of the power-amplifier tube, the maximum B plus is taken directly from the terminals of the filter circuit, as shown in Fig. 4 as B+Max. amp. This terminal provides approximately 200 volts at full load. A Clarostat, R_4, is used to control the voltage output of the next lower tap (B plus Int.) and will give from 90 to 135 volts approximately on the usual plate-current drain at this voltage. The

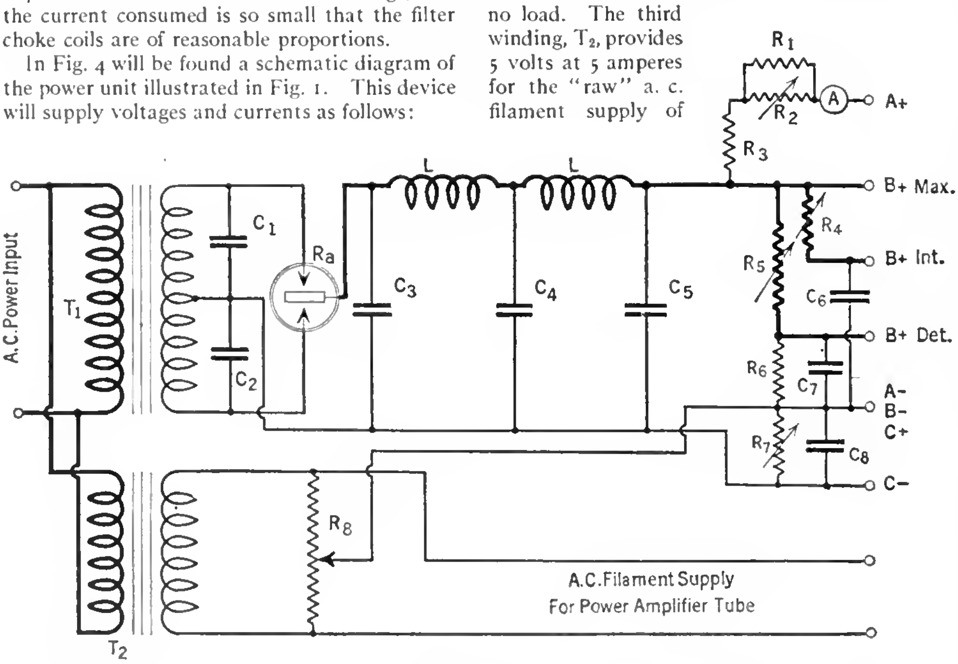


FIG. 4

The complete circuit diagram for the A, B, C line supply device described herewith, is shown above. The parts employed as listed, may be identified as follows: Ra, Raytheon type BH; R1, Ward Leonard 5000 ohms; R2, Federal No. 25 Potentiometer; R3, Ward Leonard 3000 ohms; R4, Clarostat; R5, Bradleyohm No. 10; R6, Ward-Leonard 10,000-ohm fixed resistor; R7, General Radio No. 214 Potentiometer; R8, General Radio No. 214 Potentiometer; C1, 0.1-mfd. condenser; C2, 0.1-mfd. condenser; C3, 4.0-mfd. condenser; C4, 4.0-mfd. condenser; C5, 6.0-mfd. condenser; C6, C7, C8, 1.0-mfd. condensers (condensers used in this model are Tobe Deutschmann but others with an operating voltage of 350 volts may be used); A, 0 to 75 m.a. milliammeter; L, General Radio type 366 choke, 25 henries at 85 m.a., d.c.; T1, type 365 General Radio transformer supplying 350 volts per anode; T2, Brach 8-volt bell transformer supplying 5 volts at ½ ampere

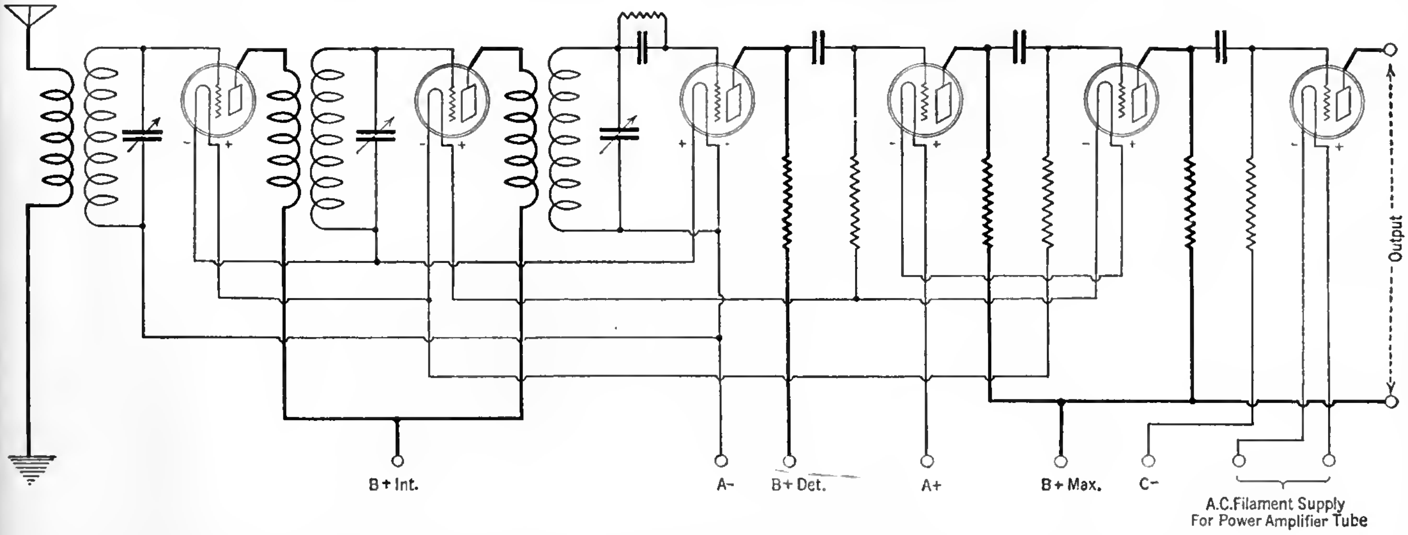


FIG. 5

To employ the line supply device described, the filament circuit of the receiver with which it is to be used must be altered so that all the filaments are connected in series. Then 199, or other 3-volt tubes, replace those formerly used, with the exception of the last stage wherein a power tube, such as the 112 or 171 may be employed. The circuit above is a typical five-tube, tuned radio-frequency receiver employing resistance-coupled audio frequency amplification

B-plus detector tap is obtained through the use of another Clarostat or a Bradleyohm No. 10, R_5; One-microfarad condensers are connected in both of these cases from the B plus variable to B minus to bypass rheostat noises, and to prevent undesirable coupling between the various amplifier stages.

THE C BATTERY SUPPLY

THE C battery is obtained from a wire-wound variable resistance of the proper value. As this resistance carries the full load current of the eliminator, it must be designed to carry from 70 to 85 milliamperes without change of resistance, and without excessive heating. If high C voltages are desired, say up to 60 volts, the Federal No. 25 potentiometer is a good resistance to use here. It has a maximum resistance of 1850 ohms, and will carry the full load current fairly satisfactorily. A General Radio No. 141 potentiometer may be used in this position to supply C voltages up to 34 volts, and does so with much less heating. A 1-mfd. condenser is connected from C plus to C minus to prevent undesirable coupling effects and distortion. If 60 volts C bias are required and 85 milliamperes pass through the resistance supplying it, the power that must be taken care of is 5.1 watts.

The a. c. filament winding, T_2, may not be available to the average constructor who may have access to a 50-watt transformer having other satisfactory windings. In this case a Thordarson doorbell ringing transformer may be used to light the filament of the power amplifier tube. This transformer will be found to give the proper voltage without a filament rheostat for the UX-171 and UX-112 tubes using the winding marked "6 volts." A 400- ohm potentiometer, R 8, is connected across the 5-volt a. c. supply and the center tap is returned to the B minus terminal of the supply unit. The adjustment of this potentiometer is very critical in order to eliminate all a. c. hum from this source.

The A plus terminal of the power supply is obtained by dropping the B plus max. through a suitable rheostat to the required A-battery voltage. The resistance used in this position should have a range of from 3000 to 5000 ohms, and a current-carrying capacity of 60 milliamperes. As there was no rheostat of these requirements available, the writer used a combination of fixed and variable resistances to achieve the degree of control required. A fixed Ward Leonard 3000-ohm unit was placed in series with a Ward-Leonard 5000-ohm fixed resistor, around which was shunted a Federal No. 25 potentiometer. With this arrangement, the required degree of current control was attained.

A filament milliammeter having a scale reading of 0-100 mils or better yet 0-75 mils is placed in series with the A-plus lead going to the radio set, and by means of the rheostat and the milliammeter, a constant current of not over 60 milliamperes can be held at all times. If the latter type of meter is not readily available at the local dealer it may be obtained from such companies as the Weston Electrical Instrument Corp. or the Jewel Electrical Instrument Co. An adjustment of the filament current will have to be made when first turning on the receiver and, after the first two or three minutes, no further adjustment need be made. Very wide fluctuations of the 110-volt house supply voltage (i.e., greater than 10 volts) will, of course, affect the value of filament current, but it will be found that setting the milliammeter at 58 milliamperes will give excellent amplification, and make allowance at the same time for those line-voltage variations which come within the usual range.

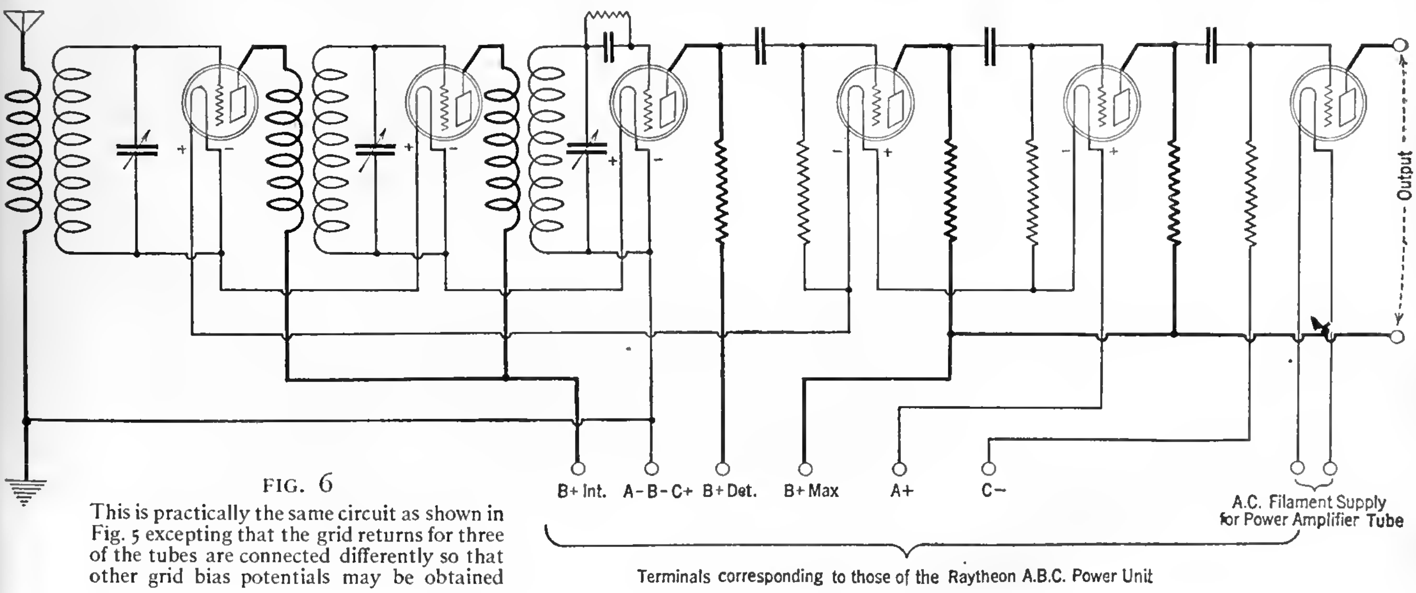


FIG. 6

This is practically the same circuit as shown in Fig. 5 excepting that the grid returns for three of the tubes are connected differently so that other grid bias potentials may be obtained

Radio Broadcast Photograph

THE FRONT VIEW

Of the line supply device presents a very pleasing appearance. It is suggested that, if the construction of a housing for this device be attempted, perforated sheet brass or just plain sheet brass with vent holes made therein, be employed

The variable arm on the 400-ohm potentiometer is set at such a point that a minimum a.c. hum is heard in the head phones when no signal is being received. It can then be left in this position without further attention. In case it is necessary to reduce the a. c. voltage available from the 5-volt winding by means of a rheostat, it will be necessary to readjust the potentiometer every time a change is made on the rheostat setting.

The experimenter desiring to build the A, B, C line supply device described in this article will find the various drawings and photographs very helpful. The different units should be mounted on the panel and base-board drilled in accordance with the drilling templates shown in Figs. 7 and 8. After mounting the parts, the base-board may be screwed to the panel and the wiring done. It will be wise to follow the exact layouts of wiring that proved to be successful in the model that was made up. The arrangement of wires is evident from the photographs. Cover all the bus bar with spaghetti so as to prevent any accidental short circuits.

Figs. 5 and 6 show conventional radio circuits which have been revised in accordance with the demands imposed by connecting the radio tube filaments in series. Any of the standard radio circuits may be revised and thus adapted to series filament service if the few fundamental features outlined below are observed.

There are, in general, two methods whereby the tube filaments may be successfully operated in series. The first method, employed in some of the Bell System circuits, makes use of the voltage drop in successive filaments as a source of grid bias in certain tubes, thereby raising the maximum value of plate voltage which may be applied to these tubes. This method is acceptable provided the current in the filament circuit is sufficiently uniform and without a. c. ripple, which would introduce a. c. hum and modulation of the radio signals. This method is somewhat more efficient from the standpoint of the amplification obtained and, if care is taken to obtain the proper bias on the various grids, it will undoubtedly serve the constructor in the most desirable manner. See Fig. 5.

The alternative method, which is perhaps simpler from the construction standpoint, is to disregard the various filament drops and connect the grid return lead of each stage to the negative side of the respective filament. See Fig. 6. It will naturally be necessary in this arrangement to reduce the plate voltage applied to these tubes to normal values consistent without grid bias. If the second method is employed, it is not necessary to provide such a high degree of filtering in the A-current supply. As high as 5 per cent. ripple has been used by the writer in this connection without too noticeable a hum in the speaker.

The power unit described in this article gives a very high degree of filtering, and the filament voltage drop can therefore be used as grid bias if the constructor desires. In this case all of the constants of the circuit must be carefully maintained. For example, the filter chokes must have a residual inductance at 85 ma. d.c. load of not less than 25 henries. The filter condensers should be arranged exactly as shown in Fig. 5, the first condenser having a capacity of 4.0 mfd., the second also 4.0 mfd., and the terminal capacity from 6.0 to 12.0 mfd., in proportion to the quality of reproduction which the builder desires. The bypass condensers placed from the variable B plus terminals to B negative and from C plus to C minus, are necessary to reduce rheostat noises and to reduce interstage coupling to a reasonable value. Their capacity should therefore be not less than 1.0 mfd. for a margin of safety. The variable C battery, provided for the grid of the power amplifier tube, is controlled by means of the variable resistor R, in Fig. 4. The value of C battery can be roughly calculated from the product of the total load current from the power supply set, and the resistance included in the A-battery rheostat. If exact values are essential, the C voltage may be measured by a high-resistance voltmeter,

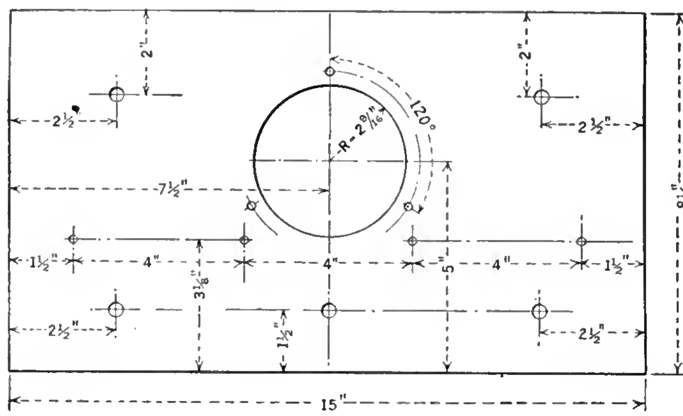
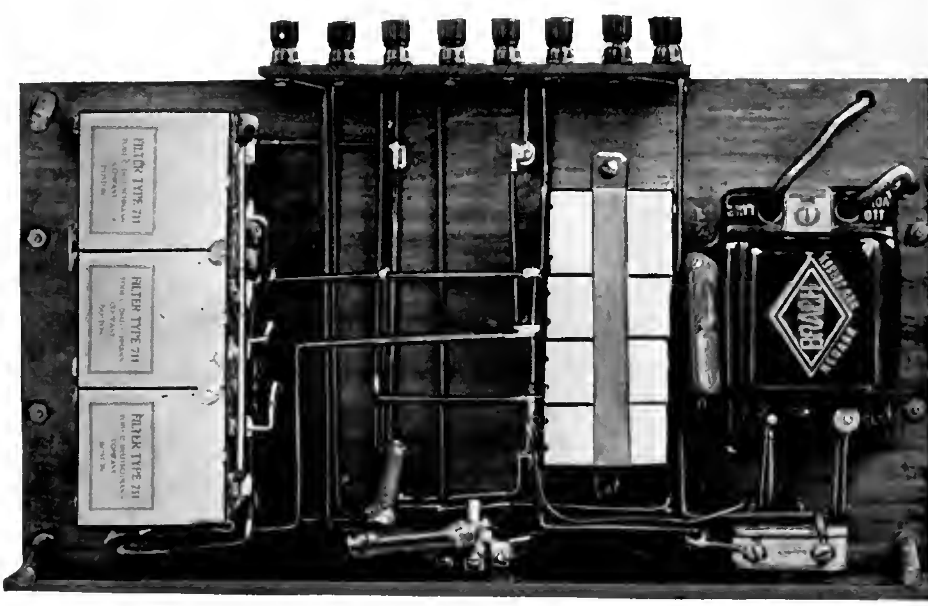


FIG. 7

The panel for the line supply device is not of the standard 7-inch width but is 8½ inches wide. The dimensions shown above enable the constructor to duplicate layout and placement of parts as shown in the accompanying photographs



Radio Broadcast Photograph

THE BOTTOM VIEW

Of the "works" assembled underneath the sub-base shows that most of the wiring of the unit is out of sight

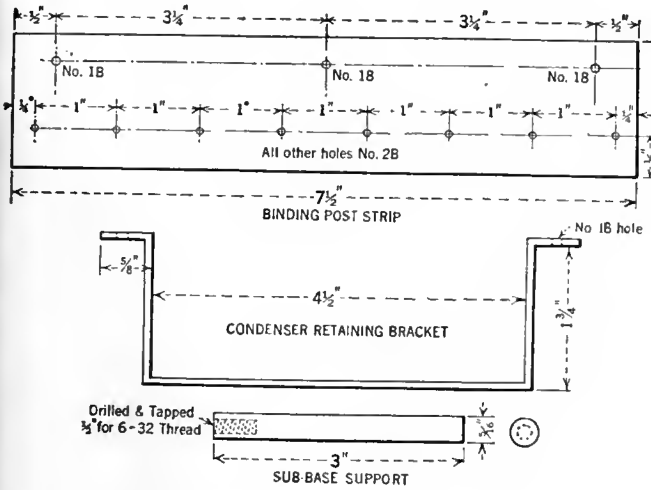


FIG. 8

A binding post strip, condenser bracket and sub-base supports may be laid out as shown here

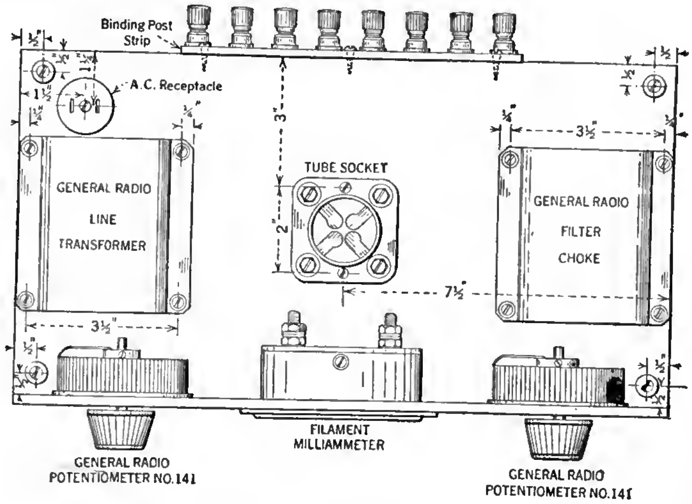


FIG. 9

Upper view of the sub-base layout. Compare this with the top view. Strict adherence to the layout shown is advised for best results

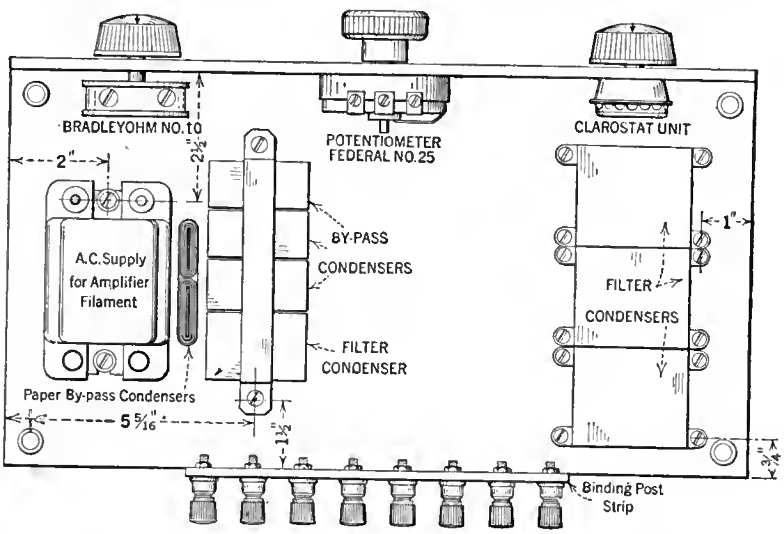
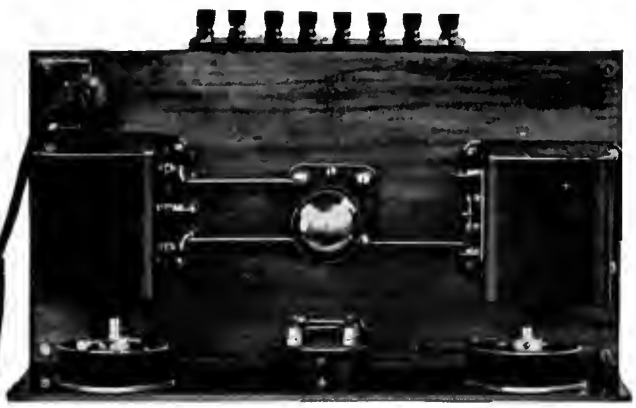


FIG. 10

This picture layout, together with the accompanying photographs, will aid materially in correctly locating the various apparatus employed in the construction An under view of the sub-base is shown



A TOP VIEW

Of the A, B, C line supply device. The use of the 85-mil. Raytheon tube makes possible the use of this unit as a source of supply for the filaments of 199 or other similar tubes

taking into consideration the amount of current drawn by the voltmeter from the power-supply circuit. This determination is not ordinarily necessary, as improper bias on the power tube will very soon become apparent from the distortion produced.

The method of operating a radio receiver with filaments connected in series is perhaps unique to many experimenters who are accustomed to constant voltage control, and for this reason the experiences of the writer may be of benefit. In the first place, it will be noticed that most of the 199 type radio tubes give at least as good service on 58 milliamperes filament current as on 60 milliamperes. Very frequently it is possible to lower this value to 56 milliamperes without lessening the degree of amplification, and in no case should it be necessary to increase the filament current over 60 milliamperes. The DV-3 type filaments have a useful range of 60 to 65 milliamperes. In starting up the power unit for use in connection with a radio receiver, first place the rheostat setting at minimum current position, and, if it is known that the minimum current is more than 50 milliamperes, it will be much better to place a 10- or 15-watt 110-volt tungsten lamp in series with the A supply to the radio set. Then, when turning on the 110-volt a.c. supply, take note of the milliammeter reading, to be sure there are no short circuits around the protective resistances. If the milliammeter reads zero, there is possibly an open circuit somewhere in the A circuit, or one of the 199 tubes has a burned-out filament. If the milliammeter reads 50 milliamperes or less, gradually increase the setting of the A rheostat until the filaments are consuming from 55 to 60 milliamperes. The B supply voltages should now be checked over and adjusted to their proper values. The potentiometer across the a. c. filament of the power-amplifier tube should be adjusted very carefully to give minimum a.c. hum when no signal is being received, and then the C voltage on this tube should be adjusted to the proper value. The filament supply may again need adjustment, setting the rheostat to give approximately 58 milliamperes for 199 type tubes, and 63 milliamperes for DV-3 type tubes.

The effect of a.c. line voltage variations upon reception will not be noticeable for normal and adequate wiring installations. A setting of 58.5 milliamperes on the filament supply will give a variation of 57 to 60 milliamperes with a line voltage variation from 105 to 120 volts. This variation in voltage is normal, and will not effect any change in volume of reproduction on most radio receivers. When turning off the power unit, it will be found advisable to place the A-supply rheostat at a minimum setting again, in order to offset the harm which might be done by a high line voltage when turning on the power unit again. With a little care, the operator will soon learn to rely upon his filament ammeter and the rheosat as the only elements of his power unit which require frequent attention.

THE NEW RAYTHEON TUBE BH

THE new Raytheon type BH tube is an improvement on the type B tube which supplies the need for an adequate B power supply rectifier. The advances in the design of the type BH tube increase the full-load rating to 85 milliamperes and 200 volts continuous d.c. load. The safe maximum a.c. voltage that may be applied to each anode has been placed at 350 r.m.s. volts a.c.

When the type BH Raytheon is placed in a B-power line supply unit which has been designed for use with the type B Raytheon, there will be an average increase in voltage output of 25 volts for the same radio set. The regulation of the type BH tube is improved so much that it has a practically constant voltage drop from 15 to 85 milliamperes of rectified current. For this reason, the regulation of B-power line supply units, using the BH type tube, can be made remarkably good.

Conducted by — John Wallace

Sad News: Why Radio Cannot Educate

AS THE result of a few random and slightly derogatory remarks made in the June number, concerning the educational possibilities of radio, your humble servant, the above-signed, has been "taken for a ride" by numerous indignant readers. We said at that time that we did not believe that radio could educate. To that statement we added the compromise: "Most of the 'blah' we read about radio as an educational factor is sincere enough and can be made true enough by the simple device of substituting the word 'informational' for 'educational,' wherever the latter appears."

On neither of these points, readers' letters notwithstanding, has our opinion changed. But we confess we were at fault in attempting to dispose of the subject in a couple of paragraphs. For education, from whatever angle you approach it, is a verbose subject and can not be tackled without considerable wordshed. And so the following, by way of elucidating our viewpoint.

The value of radio as an educational force has not been correctly estimated by either the *pro's* or the *con's*. Those individuals who have a personal interest in the matter are inclined to overestimate radio's teaching ability enormously. If you have perused any of the publicity material ladeled out by the radio education fanatics you are acquainted with the extravagance of their claims. Radio, it would seem from their accounts, is a civilizing force of epochal import. Almost overnight it is going to transform a world of yokels into a world of supermen. This contraption—radio—is a personal gift from the gods to them; and they mean to turn it, as far as possible, to their purposes. With it, they aim to place a school "marm" in every home, and breed a race of mental marvels. The purely amusement features of radio, in their opinion, are of secondary importance and only to be tolerated. This is manifestly silly. Radio is first of all an agency for entertainment. Its pedagogical rôle is decidedly of secondary consideration.

We have a deep seated prejudice against that type of mind which demands of every instrument of human devising that it serve the purpose of "uplift"; which insists that every new contrivance justify its existence by showing wherein it is of "Service"; and wherein it makes for progress. If radio is amusing, and it is, that alone is quite enough to justify its being; and it is under no compulsion to apologize for that virtue by doing missionary work on the side.

But if interested parties vastly over-estimate radio's potentialities in this field, it is likewise true that the average person is likely to underestimate greatly the undeniable instructive value that radio does possess. The listener who invariably makes haste to tune-out anything that savours of the lecture hall can have no idea of the scale upon which radio education is being attempted, nor of the success it has, in certain quarters, attained.

When we declare pigheadedly that radio cannot educate, perhaps our principal quarrel is a mere quibbling with words. The phrase "radio education" involves an unhappy choice of words. Substitute the expression "radio instruction" and we acquiesce to most of its claims. "Education," according to Mr. Webster, "implies development and discipline of both the intellectual and moral faculties. 'Instruction' and 'teaching' apply to the communication of knowledge"

The "educated" man and the "informed" man are horses of an entirely different color. In other words, the possession of a vast fund of information does not make a man educated. It is far more likely to make him a bore. Conversely, an individual may be in deplorable ignorance of the principal rivers of Asia or the line of succession to the British throne and yet possess what Mr. Webster calls "well disciplined moral and intellectual faculties."

LEADER OF THE ANGLO-PERSIANS

Louis Katzman, who conducts the orchestra "Whittall Anglo-Persian" heard through WEAF and "the chain" every Friday evening from 10 to 10:30 p. m.

For reasons which are easily apparent, radio can in no wise discipline the mind. To cite only one reason, mental discipline is gained almost exclusively from the study of so called "cultural" subjects. But cultural subjects are utterly unbroadcastable. Imagine learning Philosophy or English Composition or Psychology or Calculus or History or Sociology by radio! But radio can inform. For informing is no complicated task; it consists simply in the presentation of facts. As long as radio sticks to the simple presentation of facts, well and good. When it aspires to the teaching of such lofty and controversial subjects as Sociology or History, pooh to it!

The instructive value of radio may be considered from two points of view; first, that not consciously intended as instructive; and, second, that which is deliberately planned because it is instructive. Under the first point of view the value of radio is by no means negligible. The listener who is entertained at first by cheap music, partly because of the novelty of the radio experience, soon grows tired of hearing the same thing over and over again. He wishes something better just as he wishes an improved receiving set. Hence, the stations are requested to present a better class of music. And, as the listener becomes critical of music, he also comes to demand more of speakers. They must say something worth while and say it in a clear and convincing manner. The more speeches he hears the more comparisons he makes, and the more critical he becomes. This means a demand for better speakers. And so in this way, gradually and slowly and surely, public taste and judgment are improved.

Radio programs which are deliberately planned for instruction can be roughly divided into three sorts; first, those which are broadcast by universities to supplement their extension courses; second, those which are broadcast especially for reception in the class rooms of secondary schools; third, the miscellaneous and occasional lectures broadcast by any old station for whoever cares to listen.

The Kansas State Agricultural College (KSAC) was one of the first of the universities to make systematic use of radio in connection with its work. From the beginning of the school year in September until late in the following spring, a regular schedule of lectures is broadcast to hundreds of listeners who are registered for these courses. In addition to those who are registered, correspondence received at the college indicates that several times as many listen-in more or less regularly on the educational talks. The lectures cover a wide variety of topics, such as crop and livestock production, dairying, poultry raising, foods and nutrition, household economics, English, chemistry, botany, zoölogy, and the several major engineering fields.

These radio lectures constitute a sort of glorified correspondence course, in that those who are taking the course have the added opportunity to hear the voice and thus have, in a measure, the personal contact with the teacher which heretofore has been limited to the classroom. After each lecture is given, mimeographed copies, with such additional tabular and illustrative matter as may be desirable, are mailed to the registered listeners-in. At the end of the course an examination is given, and those who show evidence of proficiency are given a certificate. In some institutions, definite credit toward a college degree is given for satisfactory completion of radio courses.

Registration for the radio courses given by the Kansas State Agricultural College during the college year 1924-25 included 1771 individuals registered for a total of 11,431 courses While the major portion of these individuals resided in Kansas, there were registrants from more than 30 states, from several of the provinces of Canada, and from Mexico. The growing popularity of the courses is indicated by the fact that the total registration was nearly double that of the previous year while the average number of courses for which each individual registered increased from 2.5 to 6.8.

We have gone thus fully into the radio courses presented by the Kansas State Agricultural College because this institution was one of the pioneers in the field and its faculty is exceedingly enthusiastic about its possibilities. Kansas State University, the State University of Iowa, Iowa State College, Ohio State University, University of Pittsburgh, Michigan Agricultural College, Oregon Agricultural College, and a score of other institutions, are giving regular courses of instruction over the radio.

An interesting feature of the programs of several of these institutions is the half-hour of opening exercises which they are broadcasting for schools. The State University of Iowa broadcasts opening exercises for high schools which are received by some 200 of these schools. The Kansas State Agricultural College broadcasts exercises for rural schools and, in one or two states, plans are under way for broadcasting messages to schools by the state departments of public instruction.

"Educational" broadcasts which are picked up by receiving sets in grammar or high school c ass rooms are, at present the most provocative of results, for teacher is present to see that Willie and Mary get the most good out of it—if there is any good to be got. At present writing an experiment along this line is being conducted in the Chicago schools, which we shall watch with interest.

"Educational" broadcasts which emanate from commercial stations at irregular intervals and are picked up quite accidentally by an altogether casual listener are, we believe, absolutely worthless. The stuff goes in one ear and out the other.

But it is the "educational" broadcast which is offered by some University in conjunction with its regular correspondence courses that possesses the greatest possibilities and demands the greatest respect. For here, we enthusiastically concede, radio has a chance to be of undeniable service. Given an ambitious youth with a thirst for knowledge, who is, for some reason, unable to go to a college—if he is enrolled in a correspondence school his zeal to learn cannot be doubted. And if he has zeal to learn he can turn to good advantage any opportunity along that line—even radio instruction! It is to the assisting of such individuals that directors of "educational" broadcasts should turn their best effort. And they are going to have to expend considerable of effort to make these radio courses worth while.

B. A. ROLFE AND HIS PALAIS D'OR ORCHESTRA

A splendid dance orchestra, especially interesting because of the unusual use made of brass in the orchestrations. The group is heard through WEAF every Monday, Wednesday, and Friday from 12:15 to 1:15 p. m., and every Monday evening from 11 to 12 p. m., etc.

An Effective Use of the Phonograph in Broadcasting

THE use of phonographic records for material hearkens back to the earliest days of broadcasting. However, WGN managed to revive this ancient method in an interesting manner, making use of the same idea that prompted their series of "Old Time Prize Fights." Four former Presidents, Theodore Roosevelt, Warren G. Harding, Woodrow Wilson and William Howard Taft were the speakers on the program. The speeches were recorded many years ago by the Victor company.

Listeners were asked to imagine themselves on the moonlit steps of the Capitol in Washington on the evening of July 4. The great military bands of the country furnished a realistic background of music (also by means of records).

THE WBAL TRIO

A new addition to the regular features from this excellent Baltimore station. From left to right, Celia Brace, violinist, Florence Walton Otley, pianist, and Helene Broemer, 'cellist. The trio is heard Monday and Thursday nights from 8 to 9 p. m.

The cheers of the multitude, presumably gathered about the Capitol steps, could be heard. Then passed in ghostly review the three departed statesmen. Roosevelt gave his famous address on "The Farmer and the Business Man," in the forceful, staccato, hoarse-voiced manner that made him famous. Next, President Wilson, with his perfect enunciation and thoughtful deep-voiced tone, delivered an "Address to the Farmers." The slow, leisurely voice of the late Warren Harding was heard in his famous "Address at Hoboken on the Return for Burial of 5212 American soldiers, sailors, marines and nurses," given on May 23, 1921. The one living ex-president, William Howard Taft, repeated his "Labor and Capital" address, given originally in September, 1912.

DAVID ROBINSON AND JOSEPH BONIME

Artists on the New York Edison Hour, heard through WRNY, New York. David Robinson was formerly concert master with the Berlin Symphony Orchestra and assists Mr. Bonime, pianist-director of the Edison Hour

Jazz, Olden and Modern

A RECENT Royal Hour (WJZ, WRC, WGY, WCAD) which we listened to offered a program of popular music of five years back, revealing the songs which were on the lips of everyone in the early post war period. Such an exhumation is greatly to our liking, and we should like to see some weekly program furnisher specialize in reviving a different year's popular music every week. The grouping of several contemporary numbers together greatly strengthens the associations each conveys. In this particular program by the Royal Ensemble, were heard such juicy melodies of '21 as "Japanese Sandman," "Lazy," "Hot Lips," "Linger Awhile," "It Had to be You," "How Come You Do Me Like You Do," "Blowing Bubbles," "I'll Build a Stairway to Heaven," and the delectable "Wang Wang Blues."

It should be interesting, and provocative of communications, for some station to broadcast a series of such programs, one for each year, from as far back as about 1905, and then solicit a vote from its listeners as to which year was the most productive of good popular tunes. We are inclined to suspect that such a vote would result in a very low rating for the past three or four years.

We will probably be told that a series of programs exactly coinciding with out suggestion has already been broadcast by some station or other. If that be the case we are not at all perturbed; we urge that it be done again.

Germany and America Compared

AN EXPLANATION of the difference between broadcasting in America and Germany, which may be of interest to our clientele, was given in a talk by one David L. Loewe of Berlin, recently heard through WPG.

"The radio audience in Germany," according to Mr. Loewe, "is licensed to receive by the Post Office Department, and a fee of fifty cents a month is charged for all receiving licenses. This is collected by the postal carriers. It is unlawful to maintain a receiving set without such a license. The customary procedure is for the new owner of a receiving set to notify the officials that he has acquired such a set, and his name is listed. This list now includes more than 1,260,000 people.

"Broadcasting stations are managed by private interests under licenses from the Post Office Department. In addition to this, the Post Office owns the majority of shares in the broadcasting company. Furthermore, the wavelengths are determined by the Post Office.

"In order to prevent interference, these stations have coöperated in a general movement throughout Europe for the adjustment of wavelengths so that their reception difficulties may be reduced to a minimum. In the past, there was a great deal of interference but by such coöperation the situation has been materially improved.

"The stations in Germany are operating on wavelengths that are used by American stations. In addition, some of them go up to materially higher wavelengths, which fact necessitates the use of receivers different than those employed by a vast majority of Americans.

"There are a number of large stations in Berlin but they are all operated from a central studio in the Vox Haus, where finely equipped studios can house three programs going on simultaneously. One of the studios is large enough to accommodate an orchestra of 150 members. Every modern device for the reproduction of music and speech is provided in these studios.

"The remote control system is not approved of in Germany. Theatrical and operatic performances are put on at the studios.

"All those who appear before the microphone to entertain the public are paid, a considerable part of the fund derived from the licenses being devoted to this purpose. Even lecturers from the Universities are compensated for their time.

"DX reception is the exception rather than the rule; this does not mean that the people of Germany do not enjoy foreign programs; on the contrary, they get them exceedingly well by a happy process of re-broadcasting. Programs from Rome, London, Paris, Stockholm, Geneva, etc., are received on special apparatus located outside of Berlin, for instance, and rebroadcast through the big German stations on the local wavelengths. Thus, several millions of German listeners may hear with loud speaker strength, programs from practically every section of Europe."

(By permission of the proprietors of the London "Star."

HOW THE ENGLISH LOOKED AT BROADCASTING DURING THE STRIKE

Broadcast Miscellany

STATION WLS has done its share towards improving summer broadcasting by inaugurating a series of Friday night concerts last July, which is to continue to September 24. On every second Friday, the Little Symphony Orchestra of Chicago has been heard in concert. The intervening weeks have provided soloists of considerable importance, among them being Charles Marshall, Helen Freund, and Cyrena Van Gordon.

AN UNUSUAL request for broadcasting service received by KGO was by a bass fisherman who asked that the time of high and low tides be broadcast daily with the weather report. Bass, it seems, are caught in incoming tides.

THE Municipal station at Atlantic City, WPG, is now operating with the first of the new Western Electric 5000-watt broadcast transmitters. This station, however, is not authorized to use full power, although an application is on file with the Department of Commerce. The new set is designed to operate on any wavelength from 200 to 600 meters, but is adjusted to send on 299.8 meters (1000 kc). From the new summer studio on the Steel Pier, sixteen remote control stations are handled, permitting the picking up of many orchestras and bands.

necessary in so popular an entertainment. The whole organization is worthy of applause.

"If wireless had only been made an official monopoly in America, it would be a great deal more successful than it is.

"I still think that music is the most popular item in the modern broadcasting program, and jazz music, or symphonized syncopation, the best for broadcasting purposes.

"Jazz has reached such an art that one accepts the fact that there are classics in this type of music just as there are in straight symphony.

"As a matter of fact, a great number of the acknowledged classics have an added power when rendered in symphonized syncopation."

was argued by Bronislaw Malinowski and Grafton Elliot Smith. The debates are broadcast under the personal supervision of Henry Goddard Leach, editor of *The Forum*. They are later published in full in the magazine.

THE three-hundred foot antenna towers of WJZ's transmission plant at Bound Brook have a new function. In addition to supporting the six-wire "T" type cage antenna used in broadcasting, they also serve as towers of light to guide the United States Air Mail Flyers to their landing field. To make the towers visible at night, since it was impractical to wire them, red reflectors have been placed in such a manner on each tower to reflect the beam of searchlights located on the ground.

BELIEVING that radio concerts have now reached the stage where a definite audience can be counted on each week, and programs arranged long in advance, just as in the case of the regular symphony orchestras, the New York Edison Company arranged a series of nine concerts comprising a "world tour in the realm of music."

The series was presented from July 6 to August 31 during the Edison Hour—a Tuesday night feature of WRNY. The Edison Ensemble, under Josef Bonime, specialized, in each succeeding program, on the music of some one country, including America, England, Russia, Germany, France, Italy, Spain, Ireland, and the Orient.

The music was of high quality, as that of the Edison Hour has always been. The programs were popular in make-up, selection being made from the best of the well-known classics.

The unique feature of the series was the elaborate printed program which was furnished to WRNY's listeners in advance of the series. We have a copy of the syllabus, a 28-page booklet, at hand. Besides the complete programs for the series of concerts, it contains thumbnail sketches of the lives of the composers, and the story of each selection played. To the listener not already familiar with the selections played, or with the composers, this booklet must have greatly stimulated interest and doubled the pleasure in the performance. The preparation and distribution of the syllabus must have been a considerable expense, but in our opinion was well worth it, both to the listener and to the sponsor of the program.

THE DAVIS SAXOPHONE OCTET

Who present an indirect advertising program through the WEAF chain for a commercial company. Their programs, like all others of this type, are presented without objectionable "sales talk" on the part of the advertiser. The name of the sponsor and the product manufactured is announced and the rest left unsaid

THE Crosley Radio Corporation, has placed an order for the first fifty-kilowatt broadcasting equipment which Western Electric will manufacture for a few concerns. This new transmitter will cost, with the new special fireproof building to be erected near the present 5000-watt WLW transmitting station, near Harrison, Ohio, about $250,000.

A POPULAR group in the weekly indirect advertising broadcasts is the Maxwell House Coffee Hour, being presented Monday nights through WJZ. A good orchestra, which, we are told, is a prominent recording orchestra playing anonymously, is heard in a varied program of dance and ballad selections, interspersed with instrumental and vocal solos. A sample program is likely to run like this: "Blue Danube Waltz," "Nightmare Blues," "Waters of Minnetonka"—Flute Solo, "Swing Along," "Valse Poetica," Excerpts from Gershwin's "Rhapsody in Blue," "Mighty Lak a Rose," . . . and so forth. And if it be to your liking, help yourself Monday nights.

PAUL WHITEMAN, recently on tour of England with his band, had this to say to a representative of *Popular Wireless*, London, before he left for New York:

"I like the way the B. B. C. chooses its programs. There is variety, and that is what is

EASILY one of the best of the bands heard lately is that of Ben Bernie, who, at the time of writing is playing in the Berkeley-Carteret, Asbury Park, and heard through WOR. However, by the time this appears in print, Bernie may have temporarily deserted WOR for England, where he hopes to make his London début at the Kit Kat Club, some time in September. Associated with Bernie on the Asbury Park programs through the summer was the justly celebrated Arthur Pryor Band. WOR now has a one link "chain," its Wednesday and Saturday night programs being relayed by telephone lines to WMAF at South Dartmouth, Massachusetts.

A. N. GOLDSMITH, Chief Broadcast Engineer of the Radio Corporation of America, recently conducted an experiment (by means of switching secretly from phonograph to radio, and back again) which proved that radio broadcast quality of transmission has become so perfect that an average audience could not distinguish it from modern faultless phonographic reproduction.

A NEW monthly feature was inaugurated at WGBS in July when the first of a series of debates conducted under the auspices of *The Forum* was broadcast. The subject of the first debate was "Is Civilization Contagious?" It

A Shielded Dual-Control Receiver

How to build a Modern Shielded Receiver which is Remarkably Stable and Sensitive in Operation

A Six-Tube Receiver with Three Stages of Tuned Radio Frequency Amplification and Only Two Controls

COMPLETE, IN AN ATTRACTIVE WALNUT CABINET
The receiver described in this article is simplicity itself to control, as is evident from this picture from in front the metal control panel

By McMURDO SILVER

FOR several years past, very few important basic changes have been made in radio receiver design, the difference between the first neutrodyne and the latest type tuned r.f. receiver being due primarily to gradual developments and improvements rather than to any radical basic changes in operating principle. Thus we find that the tuned r.f. receiver of this season resembles very closely similar types of receivers of last year and the year before.

It is the purpose of this article to describe an interesting late-vintage receiver embodying many recently developed improvements in the art. This receiver is illustrated in the accompanying photographs, but before going into a detailed description of the functioning of the system as a whole, it might be well to consider exactly just what these improvements are.

Of the developments which have occurred, the adaptation of shielding to receivers is one of the most important. The reason for shielding can be summed up as a gain in selectivity and stability.

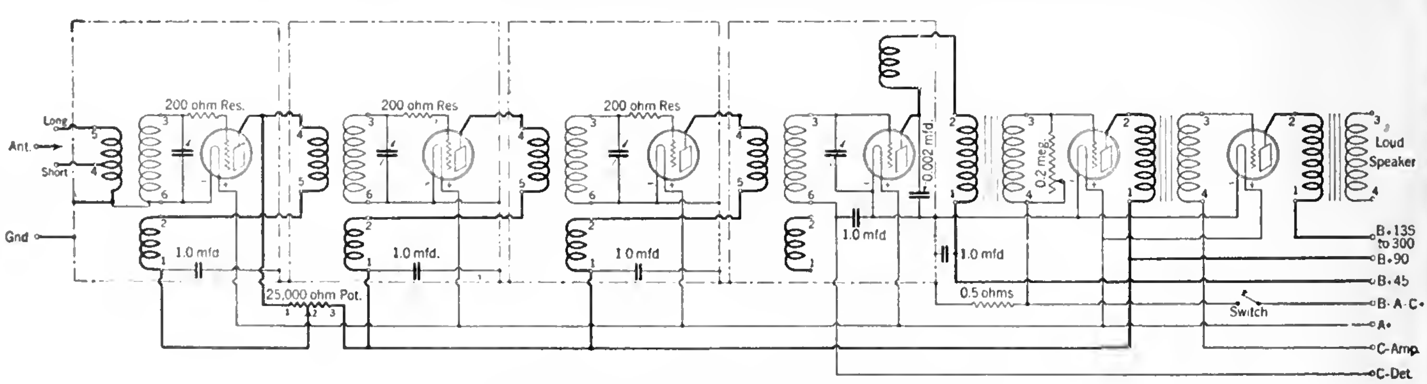
A tuned r.f. amplifier performs essentially two functions. In the first case it amplifies a very weak received signal up to a point where it will satisfactorily actuate a detector tube which may, in turn, supply sufficient power for the operation of a loud speaker. Aside from the amplification requirements, the tuned r.f. amplifier is called upon to provide a sufficient degree of selectivity so that a number of stations will not be heard all at once, but may be separated and only one received at a time. Thus we find in a tuned r.f. amplifier a succession of stages, each stage comprising a tube and its associated tuned transformer circuits. The design of the transformers is generally such as to provide a certain amount of voltage amplification, and the tube itself provides additional amplification. Each tuned transformer represents a filter circuit designed to eliminate all but one narrow band of frequencies (one station) at a time. Thus, the amplifier may be likened to a series of cascaded filters, each one designed to provide a little more selectivity and thus eliminate progressively the unwanted signals collected indiscriminately by the antenna system.

If a receiver is located close to a powerful broadcasting station, or several of them, energy will not only be picked up on the antenna system, but upon the coils and wiring of the receiver. Thus the very purpose of the successive selective circuits in an r.f. amplifier is defeated, for, instead of the signal being passed through successive stages of filtration, it impinges upon each individual circuit, and the selectivity of the receiver is no better than that of the ordinary single-circuit regenerative set. The obvious remedy lies in the prevention of energy pick-up by the individual circuits and in the forced feeding of the signal energy it is desired to amplify and reproduce through each tuned circuit successively.

Exactly as energy may be picked up by coils and wiring, so may it be radiated by the same means. Thus, in an extremely sensitive tuned r.f. receiver, the energy fed from one circuit to another, due to the close positioning of the various instruments and wiring, is sufficient to cause the circuit to break into continuous oscillation, with consequent uncontrollable squealing and inability satisfactorily to receive and amplify signals.

The simplest method of preventing this sort of interaction is to build an insensitive receiver. This means is employed in many a cheap tuned r.f. receiver where, because of inability to eliminate oscillation at some point throughout the range of the outfit, it is rendered so inefficient over its entire range that it will not oscillate at any wavelength at all, and the result, unless extremely good engineering has been involved, is a very poor receiver so far as sensitivity is concerned.

A simple solution of both of these difficulties lies in shielding. It has been found that the old



THE CIRCUIT DIAGRAM OF THE RECEIVER
The shielding used is indicated on the diagram by dotted lines. Note how bypass condensers are used in the plate circuits of all the radio frequency stages to eliminate feedback. Two antenna connections provide for either a long or short antenna. The direct current is eliminated from the windings of the loud speaker by the use of an output transformer. The 25,000-ohm potentiometer shown in the lower left hand corner of the diagram is a sensitivity control and functions to unbalance slightly the first tube. In this way a certain amount of regenerative amplification can be obtained with a considerable increase in volume. The receiver uses only two controls; the second, third, and fourth condensers being attached to a special lever arrangement which makes it possible to tune these three condensers by means of a single dial

idea that a piece of metal near an inductance increased its resistance to a simply unthinkable value, was entirely fallacious. In its place has been substituted the realization that metal near a coil will actually lower the resistance of the tuned circuit under certain conditions. It has been found that, particularly in r.f. amplifier design, metal shielding actually improves the over-all amplification of an amplifier even if it is used for no other purpose than to increase the coil resistance at certain wavelengths and perhaps decrease it at other wavelengths.

The particular advantage of such an arrangement will be appreciated when it is realized that the principal difficulty in building a satisfactory r.f. amplifier is in the maintenance of uniform amplification throughout the entire wavelength range. An ordinary r.f. amplifier will be most efficient at the lower end of its wavelength range and that its efficiency will fall off rapidly as the wavelength to which the system is tuned increases. The method of overcoming this deficiency is to introduce some device into the circuit the tendency of which will be to oppose increasingly regeneration and, consequently, oscillation, as the received frequency increases (as the wavelenth decreases). Shielding located close to an inductance may be made to have precisely this effect, for it can increase circuit resistance at short wavelengths, thereby stabilizing the system nicely, and decrease resistance in many cases at the longer wavelengths. This is very interesting as for several years past, it has been considered necessary to locate shields several feet away from the coils, not merely a matter of inches away from them.

It is thus evident that shielding serves two purposes, in that it enforces the filtering action necessary to get the required degree of selectivity, and it prevents inter-stage coupling, which results in oscillation. In accomplishing both of these ends it does something more; it allows each r.f. amplifying stage to be built to operate at almost peak efficiency, and it becomes unnecessary to render the whole system inefficient to overcome inter-stage coupling. There is still another end accomplished, *i. e.*, the possibility of adding one or more additional radio amplifying stages which will really amplify.

This leads to what is, in the present day, termed a cascade amplifier—one in which regeneration is almost entirely absent. Considering a five-tube unshielded receiver, we find that the coupling between stages is so great that a sixth tube, in the form of an additional r.f. stage, could not be added, for the inter-stage coupling would increase and cause continuous oscillation. This could be overcome only by rendering the whole system less efficient, which would in turn make the third r.f. stage of practically no value.

While shielding may not be considered the panacea for all evil, yet it eliminates, in a large measure, many undesirable conditions, and allows the construction of an r.f. amplifier embodying a third stage—each stage operating at an efficiency in excess of that obtained from last year's unshielded amplifiers.

The Facts About This Receiver

Type of circuit	Three stages of tuned radio frequency amplification, detector, and two stages of transformer-coupled audio amplification.
Number of tubes	Six. All 201-A's except the second audio tube which should be either a 112 or 171.
Features	The receiver uses four variable condensers. The second, third, and fourth are ganged together so that only two controls are necessary. All of the r.f. stages are carefully shielded to prevent unwanted interstage coupling and to improve selectivity. Negative feedback is used in all the stages to prevent oscillation. Bypass condensers are used at all points to advantage. The volume control is a variable resistance across the secondary of the first audio transformer, and the sensitivity control is a variable resistance in the plate circuit of the first r. f. tube.
Frequency range	500 to 1500 kc. (200-550 meters).

TANDEM TUNING

At THE same time that these strides toward increased receiver efficiency have been made, attention has been concentrated upon the control problem. It has been found possible to produce one- and two-control receivers quite successfully, though the one-control receivers often have an auxiliary compensating adjustment, or require a tube performing no other useful function than to permit of realization of the single-control feature. This is fully explained in Laboratory Information Sheet No. 33 in this issue of RADIO BROADCAST.

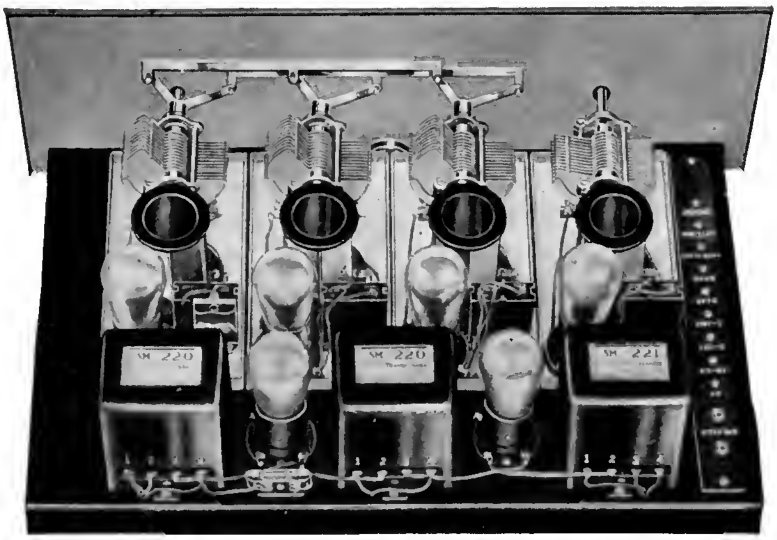
In the receiver described, the first r.f. stage is tuned separately, for its characteristics depend in a measure upon the type of antenna used. The second and third r.f. stages, together with the detector stage, operating into and out of practically identical circuit conditions, are tuned by a single control, the tuning condensers being ganged together. Several factors permit this. The first is that the circuits work into and out of similar tube impedances. The second is that in a three-stage receiver the tuning of each individual stage is necessarily broad in order to preserve quality. It is made slightly broader than in a two-stage r.f. amplifier and, as a result, the three stages can be easily controlled together, as individual circuit variations can be tolerated which would have been prohibitive in a two-stage receiver giving the same degree of selectivity. The mechanical design of coils and condensers permits of the ganging together of two or three individual circuits quite successfully.

With the advent of shielding comes what has heretofore been a tendency evident to critical observers—the gradual advent of the all-metal receiver. In the original of the receiver described in this article, a steel sub-base is used with a brass panel. Insulating material is employed only where it is necessary. As a result, the rigidity of the receiver, and its durability, are tremendously increased. Years from now the all-metal receiver will still be in thoroughly satisfactory operating condition.

The audio amplifier employed in the shielded six-tube receiver described here is of the transformer-coupled type, employing a pair of extremely sturdy audio transformers, which feed into an output transformer. The output transformer is designed to prevent saturation of the loud speaker by the direct plate current of a power tube. Such a transformer allows the full handling capacity of the loud speaker to be devoted to the handling of signal energy, to the exclusion of the direct plate current required by the tube for its operation. The common method of accomplishing this same end is through the use of a choke coil and large condenser. This arrangement has the same frequency characteristic as a loud speaker, its efficiency decreasing as the frequency becomes less, thus introducing a certain amount of distortion in the wrong direction. The output transformer employed in the model described gives greater amplification of, and ample handling capacity for low notes.

THE CIRCUIT

A SCHEMATIC diagram of the circuit described in this article is reproduced on page 494, and the functions of the various parts can be very easily explained by reference to it. The antenna is connected to the central arm of a two-point switch. One contact of this switch connects to a tap on the primary of the first r.f. transformer. The other contact connects to the extreme end of this coil. These taps are labeled "short" and "long," so that a long antenna may be used with only a small portion of the primary in circuit, and a short antenna with all of the primary in circuit. The ground connection goes directly to the metal shield, the metal sub-base of the receiver and all the shields being grounded together, taking the place of the A minus and B minus wiring of the set. The secondary of the first r.f. transformer is shunted by a tuning condenser, and is connected to the input circuit of the first vacuum tube. The output circuit of this tube goes into the primary of the second r.f. transformer in the second stage shield. The wiring then leads out and back to a small tickler winding on the coil form of the



WIRED, WITH LINK-MOTION IN PLACE

The wiring above the sub-panel is all short and direct. The two shielded transformers to the left are for audio coupling purposes while that to the right is an output transformer first r.f. transformer. The purpose of this tickler in the first stage is to aid regeneration. The low potential end of this tickler is connected through a bypass condenser directly to the shield although the B battery lead comes out from it to the volume control resistance and then on to the B battery wiring.

The volume control is connected in an unusual fashion. It consists of a 25,000-ohm especially tapered resistance, shunting both the tickler and the r.f. transformer primary of the second stage. As it is adjusted to decrease volume, resistance is added in series with the B battery but, at the same time, is decreased in shunt with the transformer primary and tickler. Thus two ends are served—the volume is effectively controlled and, simultaneously, the stability of the following r.f. stages is not impaired, and they operate in a substantially uniformly sensitive condition at all times.

This volume control also serves as a sensitivity control over the first r.f. stage only, and thus, in the hands of an experienced operator, it allows the receiver to be operated at the absolute limit of sensitivity; yet it is only a semi-critical adjustment. In the hands of an inexperienced operator, the volume control is never advanced beyond the point of instability, and is used in a retarded position to control volume. It prevents overloading in the detector or audio amplifier circuits which might cause distortion, yet does not appreciably affect tuning.

The next r.f. circuits are practically identical with the first. Fixed ticklers are again employed so that the receiver is extremely sensitive on long waves, and will oscillate satisfactorily on short waves. Excessive oscillation on the short waves is counteracted by the placing of the shielding with respect to the coils, and by small 200-ohm resistances connected in series with the grid circuits, and so arranged that they do not broaden tuning. These resistances are designed so that their impedance inceases with increasing frequency, and thus, as the wavelength of the receiver goes down, they operate to control oscillation increasingly. The overall results of these arrangements is that the tendency of the receiver to oscillate at any wavelength to which it is tuned is offset and compensated, first by the tickler action which maintains efficiency at long wavelengths, and secondly, by the various resistances which operate increasingly to stabilize the receiver as the wavelength is decreased. An extremely fine balance has been arrived at which provides a sensitive system for the entire broadcast wavelength band.

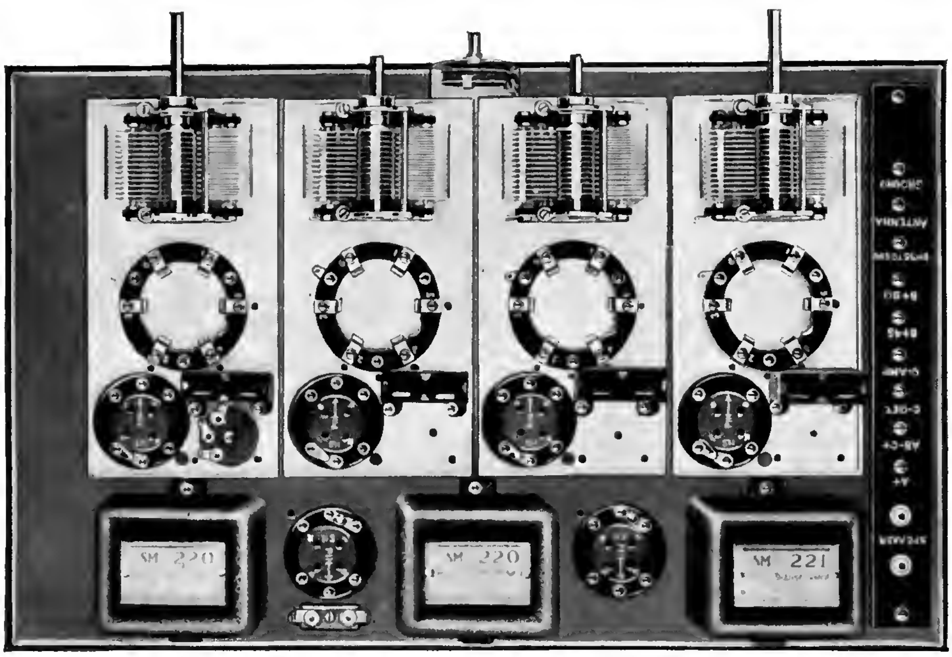
Due to the design of the r.f. transformers employed in this model an extremely high value of magnetic coupling is obtained by an exceptionally large primary, and yet, due to the spacing between primary and secondary, the capacitative coupling is kept quite low. Thus the successive stages cascade very well, and the desired filtering action of the tuned circuits is not defeated by capacity bypass from stage to stage.

In the detector compartment, the small tickler coil has been ignored and is not used at all. A choke coil is employed to prevent any of the r.f. energy getting out into the audio amplifier, which would result in a certain amount of distortion and instability. A C-battery detector is employed as the handling capacity of such an arrangement is much greater than were a grid condenser and leak utilized. Furthermore, the similarity of the second, third, and detector stage ganged circuits is maintained quite uniform by the elimination of the condenser and leak.

The audio amplifier is arranged along the back of the receiver behind the individually shielded r.f. circuits. The transformers are shielded in heavy metal housings which ground to the steel base. The first audio amplifier operates with a negative grid bias obtained from the voltage drop across the filament resistance of one-half ohm. The bias for the second tube must be provided by a C battery, and will vary with the type of tube employed, which might be either an UX-112 or an UX-171 type tube. A grid leak is connected across the secondary of the first audio stage to provide a load into which the transformer may work (more necessary at this point than in the second stage). All bypass condensers have one side grounded to the shielding or metal base, as have all tuning condensers.

A fixed filament resistance is used, for it has been found that, with UX-201-A, UX-112, or UX-171 tubes, the filament voltage is uncritical throughout the useful charge life of a standard six-volt battery.

The construction of the receiver is absurdly simple because standard parts are available which fit together very nicely, so simply that only a screw driver and a pair of pincers are needed to assemble the whole set. A list of the necessary parts is given below, and it is suggested that, while substitution may be indulged in, no effort be made to alter the arrangement, layout, or type of equipment used in the r.f. portions of the circuit, as the entire operation of the receiver depends upon even such small matters as spacing and wiring arrangement in these sections.



READY FOR WIRING

All the parts have been mounted and we are now ready to start on the wiring. All parts are fastened down with $\frac{6}{32}$ machine screws and nuts

4 S-M 631 Stage Shields
2 S-M 316A Condensers
2 S-M 316B Condensers
4 S-M 515 Coil Sockets
3 S-M 115A Coils
1 S-M 116A Coil
3 Carter 200-ohm Resistances
2 Kurz-Kash Zero Left 4-inch Dials
1 S-M 275 Choke Coil
6 S-M 511 Tube Sockets
2 S-M 220 Audio Transformers
1 S-M 221 Output Transformer
1 Polymet 0.002-mfd. Condenser
5 Polymet 1.0-mfd. Condensers
1 S-M 632 Link-Motion
2 Carter Tip Jacks
1 Terminal Strip with Terminals
1 Crowe Metal Panel, Pierced
1 Steel Base, Pierced
1 Yaxley 10 Switch
1 Yaxley Special Antenna Switch
1 Carter 25,000-ohm "Hipot"
1 Carter 0.5-ohm Resistor
1 Polymet 0.2 meg. Resistance
1 Polymet Resistance Mounting
1 Coil Belden or similar Hook-up Wire
Assortment Miscellaneous Screws, Nuts, and Lugs

THE ASSEMBLY

IN ASSEMBLING a receiver, there are certain progressive steps which may be very easily followed, and, if followed, will result in a most simple assembly. The photograph looking straight down upon the mounted sub-base, should be very carefully examined.

The first step is to put the volume control resistance in place. The one specified in the list of parts is accompanied by a pair of punched fiber washers. The lock nut should be unscrewed from the bushing and one washer slipped over the bushing so that the ridge on its inner surface projects away from the resistance itself and toward the sub-base, when it is assembled. The three extensions holding the binding posts should be carefully bent so that when the resistance is in place they will not short upon the shield. In order to hold it temporarily in position, the lock nut is then put back upon the bushing on the outside of the sub-base. Were this not done, it would be impossible to get the resistance into place after the shield pans were fastened down.

The next step will be to fasten the tip jacks on the terminal strip in such a fashion that when the terminal strip is placed in position neither the tip jacks nor the lugs attached to the various binding posts will touch the metal sub-base at any point. Next, take all of the stage shield bottoms and lay them down toward the front of the sub-base so that the holes in them will coincide with the holes in the sub-base. This having been done, the tube sockets should be put in each pan and two machine screws put through the holes found in each socket, through the shield pans, through the sub-base, and into nuts on the underside of the sub-base. The position of these sockets is clearly illustrated in the photographs. It will be noticed that the mounting screw between the filament terminals serves as the negative filament connection to the shield by means of a lug under its head soldered to another lug under the head of the binding post screw of the negative filament terminal of each tube socket. The two tube sockets for the audio amplifier may also be put in place, together with the grid leak mount, which falls, as shown in the photograph, behind the first audio socket.

The next step is to mount the coil sockets with their terminals falling as shown in the photographs. All of these sockets, except that in the detector compartment, have a lug placed between the bakelite ring and the shield through which the mounting screw falling between terminals three and six passes. A wire is then soldered to this lug and, in turn, to a lug on terminal 6 of these coil sockets. At the detector stage, terminal 6 connects to one lug of the bypass condenser and then goes out through the shield and to the binding post marked "C minus detector" on the terminal strip. The four bypass condensers may be put in place in their pans, the bottom of their mounting feet being carefully scraped so that they will make good metalic contact with the shield where the screws pass through them. The four variable condensers are fastened as shown in the photographs, the two with the extra long shafts going in the two end shield pans. When these condensers are properly mounted, the shafts of the two central ones should not project beyond the edge of the sub-base. If they do, they should be moved backwards by loosening the set screws holding the lock collar and rotor plate assembly to the shaft, re-locating the shafts further back.

The condensers must be very carefully examined to see that when the rotor plates are turned they interleave between the stator plates in the center of the intervening spaces. Should any stress be imposed upon them, this may be compensated by moving the stator plate sections either forward or back. This adjustment is made by means of the nuts upon the tie-bars anchored in the bakelite strips. Such an adjustment will probably be unnecessary, but it is well to be familiar with it in case the equipment has been roughly handled in transit.

The audio transformers and output transformer may be placed on the sub-base, as shown in the photographs, with their terminals projecting toward the rear. On the bottom of the sub-base it is necessary to mount the one-half ohm filament resistance, using one of the mounting screws of the receiver, which will hold one end tight to the sub-base, and allow the other end to be soldered to one of the contacts of the "On-Off" switch. The condenser between the 45-volt terminal and negative A is fastened in position on the underside of the sub-base also using conveniently accessible mounting screws. In every case where a mounting screw is used to carry a circuit, as would be the case with this resistance or some of the tube socket mounting screws, it is essential that the sub-base be scraped clean of enamel at the place where the nuts or screw heads come in contact with it. The same applies to some portion of the space under each shield pan on the sub-base in order that there may be positive contact between each shield pan and the metal sub-base.

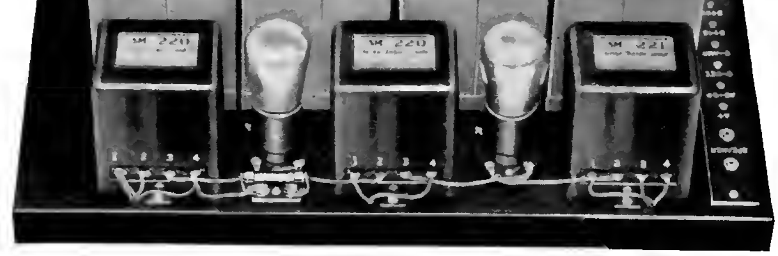
The wiring of the receiver is done by means of flexible Belden hook-up wire. This wire is composed of a number of fine tinned strands, insulated by a rubber covering. It should be cut to the required lengths and soldered either to the lugs on the instruments themselves or to lugs placed under the terminal screws of the various instruments. If preferred, a sufficient portion of the wire may be scraped to allow it to go under the heads of the terminal screws and no soldering will be needed at such connections. The small 200-ohm resistances should be used as the connecting lead between the grid terminal of each of the r.f. amplifier tube sockets and terminal No. 3 of the coil socket. A wire then leads from terminal No. 3 of the coil socket to the nearest lug locked by a nut to one of the condenser stator bars anchored in the bakelite insulating strip. In the three r.f. stages, terminal No. 6 goes to the shield as previously mentioned, while in the detector circuit it goes to the 1.0-mfd. bypass condenser, and then out to the "C minus-detector" terminal on the terminal strip. In the antenna stage, terminals 4 and 5 run to the antenna switch outside contacts, while the inside contact of this switch goes to the antenna binding post. The ground binding post connects directly to the shield. One side of each 1.0-mfd. bypass condenser goes directly to the shield, the lead preferably ending at the soldered joint between the two lugs linking the negative terminal of the stage tube socket to the mounting screw going through the sub-base. In the detector stage, the plate terminal of the tube socket is connected to one extreme lug of the choke coil and also to one side of the 0.002-mfd. condenser, the other side of which is soldered to the lug of the 1.0-mfd. condenser which is grounded. The center contact of the choke coil is ignored, the other extreme lug being connected to a wire going out through the battery-lead hole to terminal No. 2 of the first audio transformer. In connecting the volume resistance in circuit, the right-hand post viewed from the rear runs through a wire to a splice, beneath the sub-base, in the lead connecting the plate of the antenna stage r.f. amplifier tube and terminal No. 4 of the coil socket in the next r.f. amplifier stage. The center arm of the resistance goes to terminal No. 1 of the coil socket through the battery-lead in the first stage compartment joining to one side of the 1.0-mfd. bypass condenser. The other end post of the volume resistance eventually terminates in the "B plus 90" post on the terminal strip.

The whole wiring is an extremely simple matter and can be very easily effected by a novice unfamiliar with circuit diagram reading by simply following the numeral designations in the schematic diagram, the photographs, and on the parts themselves. No actual knowledge of symbols is required whatsoever, though, by the time the builder has wired the receiver, he will have a fair working knowledge of schematic diagram reading, if not before.

All wiring having been done and the antenna and battery switch having been previously temporarily fastened in place on the sub-base in their regular positions, the locking nuts are now removed from them as well as the lock nut on the volume control resistance. The front panel is then put in place and the nuts screwed up tight again upon the antenna and "On-Off" switch. The second of the fibre washers is placed over the bushing of the volume control with its central circular projection extending inward so that the metal bushing and lock nut of this resistance do not actually come in contact with the metal sub-base at any point. It is vitally important that the volume resistance make no metallic contact with the sub-base in any way, and if the insulating washers are properly used, no trouble will be experienced.

BENEATH THE SUB-BASE

All battery wiring is carried well away from the three groups of two leads that run from one stage to the next, and which appear along the center line of the base. A splice is visible in one lead running to the volume control resistance, and its position in the wiring is quite important



A GENERAL REAR VIEW OF THE RECEIVER

The individual stage covers are in place here. The two visible tubes are the audio stages

GANGING THE CONDENSERS

THE ganging of the condensers is the next operation. The set-screws in the link-motion shaft collars should be loosened and the shaft collars slipped over the three right-hand condenser shafts (viewed from the front). The condensers should then be turned so that their plates are just ready to interleave. This can only be determined by very careful sighting through the space between plate edges. The link-motion should then be turned around so that the builder will get an idea of its operation, it being remembered that when it is locked to the shafts, the condensers must move together from the "all out" to the "all in" position. With the condenser plate edges lined up as suggested, the link motion is locked in place by means of the set screws in the shaft collars. This being done, and the position of the plates checked immediately afterwards to make sure they have not changed in the operation, it should be possible to rotate all three condensers simultaneously and with a comparatively smooth even movement. The stiffness of the movement may be adjusted by loosening the lock collar on the condenser shafts and moving them to or away from the frame, which varies the compression on the spring tension washers. The compression bearings adjusted by screws (there are two on each condenser) should not be tampered with unless a pronounced side play is felt in the bearings, these being provided only for take-up. After this operation is completed, the link-motion should occupy a position on the condenser shafts which will allow the panel to be fastened up against the edge of the sub-base without the link-motion scraping it, and also so that there will be plenty of space between the link-motion shaft collars and the condenser shaft lock collars in which space the edge of the stage shields will have to come.

The receiver is now completed, but before being put into operation, the wiring should be most carefully checked to make sure that no errors have been made in it. The volume control knob is so adjusted on the shaft that when the contact arm is all the way to the right, the knob arrow will point directly upward. The dials on the control condenser shafts are so adjusted that they will read zero against their indicating marks when the condensers are entirely interleaving. The three type 115-A coils are put in all coil sockets except the antenna stage. In the antenna coil socket, the type 116-A coil should be placed.

Five 201-A type tubes should be inserted in the r.f., detector, and first audio tube sockets, and either an UX-112 or UX-171 in the second audio stage socket between the 221 and one of the 220 audio transformers. The 0.25-megohm resistance is placed in the resistance clip behind the first audio tube designed to take it.

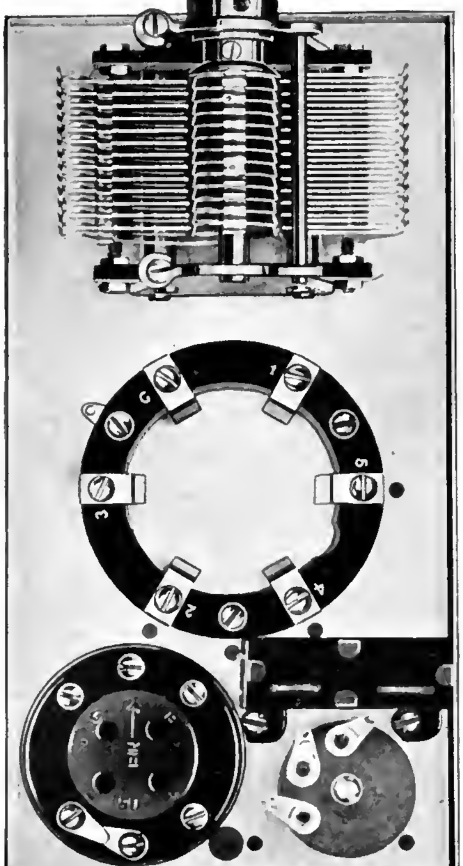
Through a seven-lead Belden battery cable, all battery connections will be made. The A battery should be a six-volt 80- to 100-ampere hour type. The detector C battery may be a standard four and one-half volt one, and the amplifier C battery will be either three of these four and one-half volt batteries for a 112 type power tube or a small twenty-two and one-half volt B battery for a 171 type power tube. The B batteries consist of four large size forty-five volt batteries of the heavy duty type, or a good standard B supply device. The plus connections of all C batteries will come to the minus connection of the A battery and the minus of the B battery supply.

Before the B and C batteries are actually connected, if the A circuit be completed and the "On-Off" switch turned on, the tubes should light. This would indicate correct wiring, and the plus A-battery lead should then be touched successively to every other binding post on the terminal strip. As this is done the tubes should not light. If they do, it indicates an improper connection, or grounding of the volume control resistance to the metal frame of the receiver. This condition must be corrected before proceeding further, as the tubes should only light with the A battery connected to the proper posts.

Assuming all to be well, and all batteries hooked up, the tips of a loud speaker cord should be pushed into the tip jacks and the ground binding post of the receiver run through a wire to some suitable ground system. The antenna lead-in goes to the antenna binding post, the antenna itself preferably being a single wire affair from thirty to sixty or seventy feet long, and preferably an outdoor one.

The receiver is now ready for operation, assuming all tubes to light and the previous tests to have been gone through. The stage shield covers are put in place with the slots in their ends falling over the condenser shafts. Care should be taken to see that their edges fall well inside the edges of the bottom pans and that they fit in place snugly.

The operation of the receiver is very simple, and hardly merits description. With the antenna switch thrown in the "Long" position, the "On-Off" switch, "On," the two large dials should be rotated slowly down their scales, holding approximately the same dial settings. Stations should be heard, and their dial readings may be written down for future reference. The selectivity of the receiver will be affected by the position of the antenna switch. If the leads from the first coil socket to the switch are correct, the receiver will be most selective and signals weakest in the "Short" position, while they will be louder and the receiver less selective with the switch in the "Long" position. As the volume control is turned all the way to the right, a click will probably be heard as the two tuning dials come into resonance, and if they are tuned to a station, a slight squeal will be heard. This is remedied by turning the volume control knob to the left until the squeal disappears and the receiver may be then tuned without resorting to this knob except that it may be retarded further to the left to lower the volume of the received signal. In hunting for extremely weak DX stations, the volume knob should be kept just to the left of the point where the clicking or squealing is heard, as the receiver is then in its most sensitive condition.



AN INDIVIDUAL STAGE ASSEMBLY

The small choke-coil spool is used only in the detector stage. The large hole is used for battery wiring; the smaller holes around the coil socket for other connections

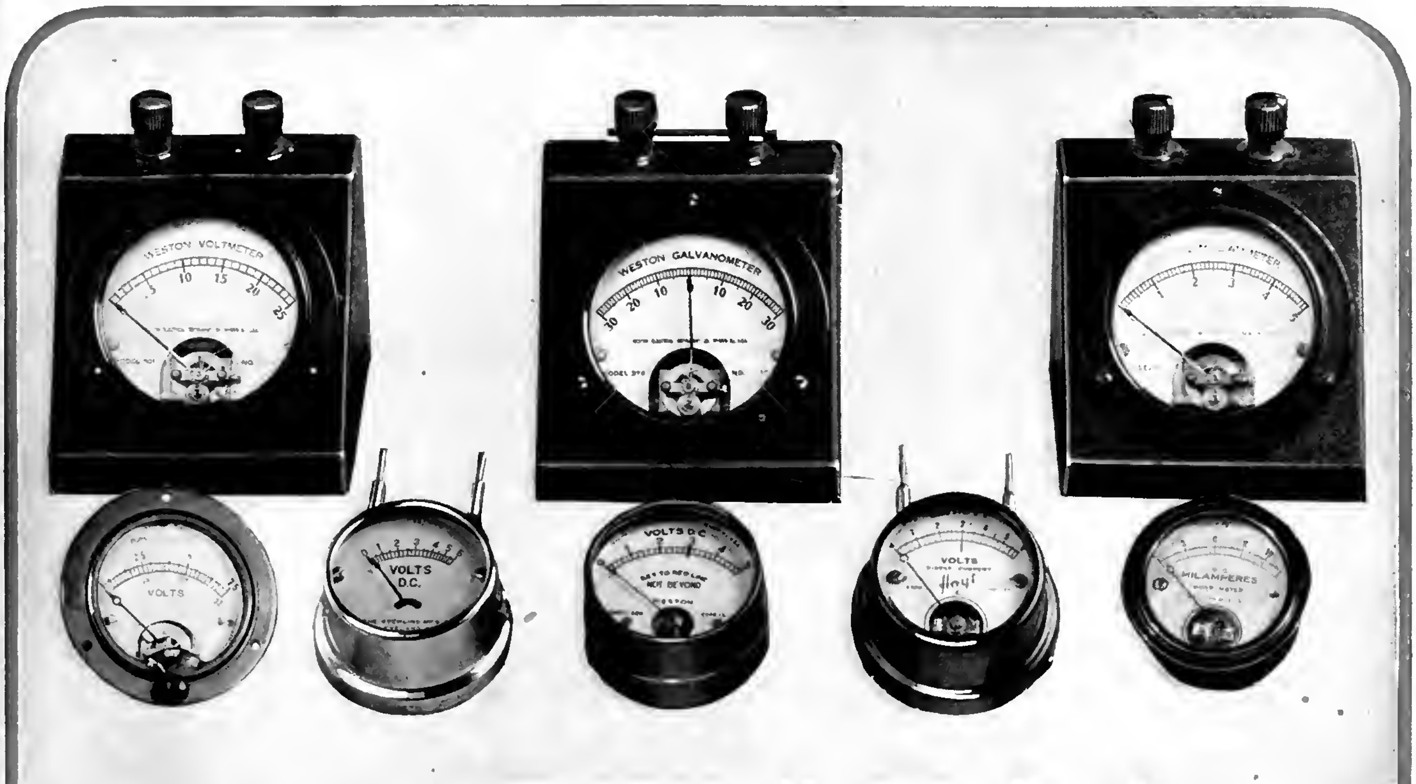
There are a few precautions to be offered with respect to the outfit. In the construction, care should be taken to keep all leads in the stage shields short and direct. In operation, the loud speaker should not be located too close to, or on, the receiver cabinet, as a continuous low pitched howling may result. If this trouble is experienced, wrapping the detector tube in cloth, to prevent vibration, should eliminate it. With the receiver in a cabinet, it is a good plan to lay some old soft cloth drapes over the aluminum stage shields in order to prevent them vibrating mechanically, as a result of the loud speaker vibrations, and communicating these on to the tubes. This is a very important fact, but is seldom encountered except in receivers giving very good low note reproduction and having individual metallic stage shields close to the detector tube, which may vibrate mechanically.

One very important caution is the use of nothing but the best B and C batteries. If a line supply device is used, it must be checked to see that its voltage is ample for the operation of the set, as many such devices are not capable of supplying an outfit of this type. If any difficulty is experienced with poor quality when using line supply device, or from howling, it can be eliminated by the addition of, say four 1.0-mfd. condensers across the output of the eliminator, or across the B battery terminals of the receiver.

A final caution is in the matter of tubes. None but thoroughly good tested tubes should be used in the r.f. amplifier and detector stages. An UX-200 tube can be used for the detector, but it is not recommended by the author. Either an UX-201-A or an UX-112 type tube may be used for the first stage, the latter being recommended as giving better quality of reproduction. An UX-112 or an UX-171 type tube may be used for the last stage; under no circumstances use an UX-201-A as it will be sadly overloaded in practically all cases.

There is no critical balancing adjustment in the receiver with the exception of a single one which may be completely ignored unless the builder wants the absolute limit from the outfit. If this is the case, then two twelve-inch lengths of hook-up wire should be very tightly twisted together with their ends insulated from each other. One end of each wire is then scraped clean. These two pieces of wire form a condenser, one side terminating on the shield of the detector compartment and the other terminating on the grid post of the detector tube socket. This wire condenser may be rolled up in a small lump so that it will fit inside of the stage shield without being closer than one-quarter inch to the inductance coil of the detector circuit. It is well to remember that this precaution increases the sensitivity of the receiver very slightly, but is not worth while unless the builder wishes to get a very small additional gain from the whole system.

The ganging of the condensers specified will be accurate if it is done in the manner outlined, for each individual condenser is carefully measured before leaving the factory. If the essential parts are procured in kits, they will inter-change with each other as their characteristics are identical, laboratory measurements having assured a far greater degree of uniformity than is actually required.



RADIO BROADCAST Photograph

INSTRUMENTS VALUABLE IN MEASURING TUBE CHARACTERISTICS

The above photograph illustrates a few of the essential electrical instruments used in obtaining the data given in this article. In the lower left hand corner is shown the DeWitt La France tube tester. In the interest of more satisfactory operation of dry-cell operated tubes, voltmeters are available in which the 3-volt setting is marked on the scale by a red line. Such meters are illustrated in the above group

How to Measure Your Own Tubes

The Electrical Standards by Which Tubes Are Judged and How the Home Experimenter May Collect His Own Data on Tubes With Simple and Inexpensive Equipment—Another Article in the Series for the Home Laboratory Worker

By KEITH HENNEY

Director, Radio Broadcast Laboratory

WERE we to sit down and mentally review the important events in radio for the last twelvemonth, not the least of our considerations would be the tremendous forward strides taken by the vacuum tube industry. It was not so long ago that we would pay less attention to the tubes when installing a new receiver than we would to the bulbs in the lamps when purchasing an automobile. Nowadays, however, we are accustomed to believe that there is a tube for every purpose, and the impeccably equipped receiver will often be found to be wired for practically as many volts grid bias alone as were the receivers of yore for plate potential! Tubes specially adapted for r.f. amplification, others for detecting, and still others for the various audio stages, have been produced, and it is due to no mere idle prattle on the part of the manufacturers that they have sprung into instant popularity.

Now that the radio listener can procure special purpose tubes, he naturally wants to know what tube to use, and how, and when. Then he wants to know why such and such a tube fills a particular need. And finally, if he is a born experimenter, as most radio enthusiasts are, he wants to know how he can tell whether such and such a tube is the one he needs for a particular purpose.

Now there are any number of ways by which one can get tube information. For example, there is the printed sheet that comes with the tube when you buy it, which gives the proper voltages to use. These latter, thanks to the tube manufacturers, are practically always the same for similar types of tubes from different manufacturers. For example, five volts is the customary filament voltage of storage battery tubes, with about 45 volts on the plate of the detectors and from 90 to 180 for the amplifiers. For each plate voltage there is a certain C voltage that should be used, and it is a pity that more people do not pay attention to this point.

But on the carton, and on the directions slip within the carton, there is little information about such things as plate impedance, or amplification factor. Some enterprising manufacturers enclose characteristic curves with the

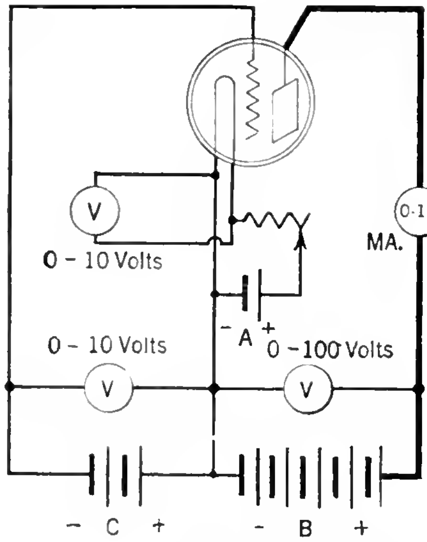
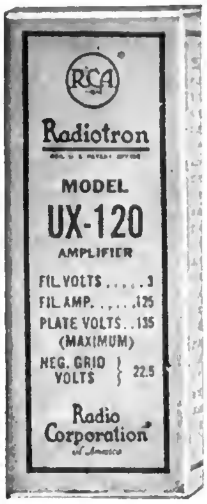


FIG. 1

The connections for the various instruments to be used in measuring tube constants are shown in this diagram



A TYPICAL TUBE CARTON

A certain amount of data is given on the tube cartons themselves

necessary data but there are few indeed in this category.

One can get information from the manufacturers by writing; for most of them know all about their own tubes. Again, magazines and newspapers have published articles on tubes, giving much important data. But these data are general, and usually apply to 199 or 201-A tubes as a class, and do not tell one what happens when the tube gets old, when the various voltages are changed, or when any one of a number of other variables are "monkeyed" with.

HOW ONE MAY FIND OUT ABOUT HIS OWN TUBES

AND, while there are any number of people who are content to take information and advice that is handed out by others there are quite a few who prefer to get the information for themselves. And not all of these people live in Missouri, either!

Radio Broadcast has already published considerable data on tubes, data which have come from experiments in the Laboratory. For example, in December, 1925, something was said about the new power tubes, how much power was obtainable, and how much was necessary for satisfactory reproduction. In February, 1926, data were published on the proper uses of tubes and, in April, was described the effect of adding resistance loads to tubes, as well as a discussion of the several methods of coupling loud speakers to power tubes.

In the present article, we shall show how remarkably simple is the apparatus necessary to experiment and measure the important constants of tubes. The main apparatus, outside of the tubes themselves, consists of two meters, a voltmeter and a milliammeter. As a matter of fact, one meter will do, provided one has the means at hand for calibrating a milliammeter as a voltmeter; this was described in the Laboratory Information sheets in the September Radio Broadcast.

The voltmeter should be a double range affair, such as the Jewell Model 55, or Weston Model 506, or the Hoyt Rotary meter (which is both milliammeter and voltmeter, so that one has several meters in one.)

With such a voltmeter, one may first adjust the filament voltage properly and then use the instrument to measure or adjust the grid and plate voltages.

The milliammeter must be capable of measuring both large and small currents, which is a lot to ask of any one meter. The Hoyt meter will do this without trouble since it has a 7.5-milliampere scale as well as one for 75 milliamperes, and two voltmeter scales as well. It is a simple matter, however, to adjust an ordinary meter so that it will read accurately the plate current of a small receiving tube—say one milliampere—or the output of a power tube, which may be thirty or more milliamperes. The answer lies in a sensitive meter combined with several shunts.

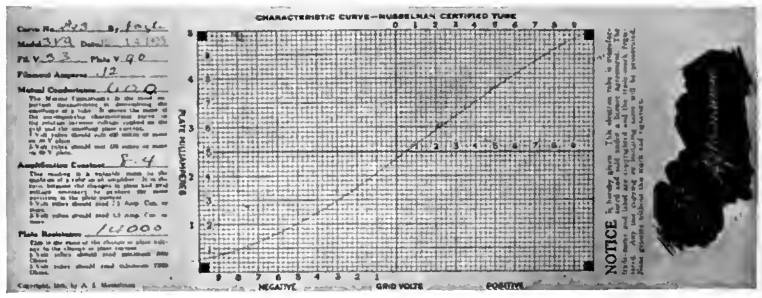
With a shunt, a meter that ordinarily reads ten milliamperes, a hundredth of an ampere, full scale, will read twice, four times, or any number of times that amount, depending upon the resistance of the shunt employed. Thus, with a shunt included, when the needle points to, say, ten mils., it really means that twenty, forty, or perhaps one hundred, etc., are actually flowing in the circuit. In making up a shunt, it is very easy to find the correct resistance by the "cut and try" method. For practically all meters a 6-ohm rheostat will serve as a satisfactory resistance. If we have a 5-milliampere meter and desire to read 50 milliamperes, we first connect the meter in circuit and read the deflection. The rheostat is then connected in parallel and varied until the meter deflection is only one-tenth as great. (The total current in the circuit should be held constant). Now, when the meter reads 5 milliamperes, the total current in the circuit will be 50 milliamperes.

The important thing is to procure as accurate a meter as the pocketbook will permit. Weston Model 301 meters are ideal for the home laboratory, and similar types by other manufacturers are eminently desirable. The meter for the purpose of measuring tubes may have a full scale reading of five, ten, and not over twenty-five milliamperes.

HOW TO MEASURE TUBES

HAVING equipped ourselves with a meter that will read 0 to 10 volts and from 0 to 100 volts, and a suitable milliammeter, let us proceed with the all-important business of measuring tubes.

Suppose we start with a 201-A, the most popular type of tube used in America. The important things we wish to know are the effect of grid voltage and plate voltage on the plate current, the amplification factor, the plate impedance, and the mutual conductance in case we feel that this latter is the criterion by which to judge the worth of tubes.



CURVES

Are included within the cartons by some progressive tube manufacturers. This particular one includes individual tube data which some manufacturers do not go to the trouble to give

The first thing to do is to set up our apparatus according to Fig. 1. The voltmeter enables us to set the voltage across the filament at 5.0. Then we connect the voltmeter across the B battery and measure this voltage, afterwards connecting it between the grid and the negative filament lead to read the C bias voltage.

Here a few words of caution are apropos. If the C bias is to be continuously variable, a potentiometer across a battery is necessary. If the C battery is the customary 4.5-volt block and the potentiometer is one of 400 ohms resistance, Ohms' Law tells us that 10 milliamperes are flowing—which is not good for the battery. It is better to use a storage battery or bank of dry cells so that the bias may be varied in steps of 2 or 1.5 volts respectively, which is close enough for all ordinary measurements. We have now:

1. Set the filament voltage at 5.0.
2. Read the B battery voltage.

and the next step is:

3. Adjust the C bias until the plate current is zero.

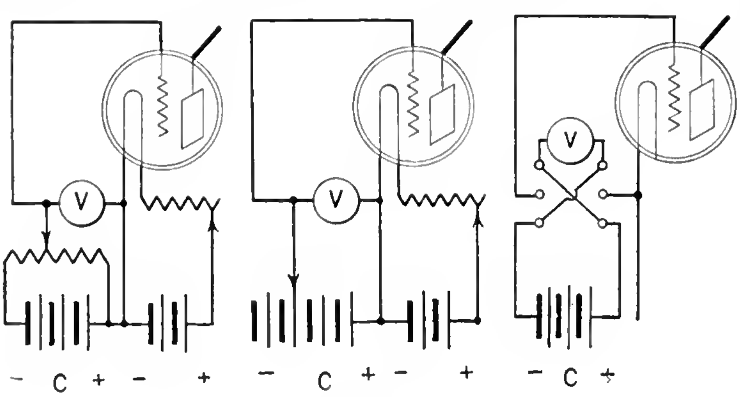
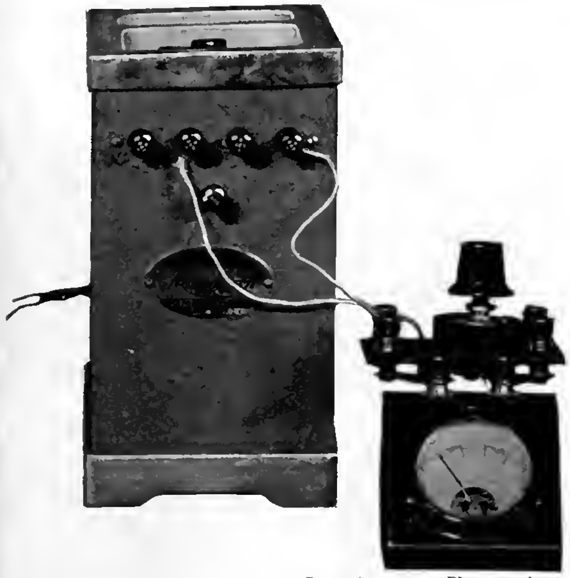


FIG. 2

Two methods of getting bias voltages for the grid are shown in this diagram. That using the potentiometer is bad for the batteries but permits of close regulation. A double-pole double-throw switch is wired as shown in the right-hand diagram for changing from a negative to a positive potential



RADIO BROADCAST Photograph

A SHUNT IN USE

Although the needle on this 5-milliampere meter points to 1 mil., by virtue of the fact that a shunt is included, it is really passing 10 mils. The shunt shown has a resistance of a very few ohms. The voltage source here is a "Mayolian," and a Clarostat is employed to regulate the amount of current

4. Reduce the negative C bias in small steps and read the plate current.
5. Continue until the grid is about 10 volts positive.

Fig. 2 shows a simple method of reversing the C battery to get positive bias. The plate current will be zero at about 2.5 negative voltage on the grid if the plate voltage is about 22.5, and will be about 4 milliamperes with positive 5 volts on the grid. Now:

6. Increase the B voltage and repeat step 4.

When we have 90 volts on the plate and get the C bias to about positive 2.5, the plate current will be about 10 mils. and, if we have a ten-mil. meter, we shall have to worry about the shunt already mentioned. If the meter only reads 5 milliamperes, we shall have been in trouble before this.

The problem is to make our meter indicate a flow of greater currents without damage to it. We proceed as follows: We set the C bias until the plate current is some value near 5 mils on a 10-mil. meter. Any value that we can read accurately will do. Now we connect an ordinary low resistance rheostat across the meter terminals and adjust it until the meter reads one fifth —*i.e.*, 1 mil. if it reads 5 mils. without the shunt. The meter with the rheostat now indicates only one fifth of the current actually owing, so we must multiply what the meter says by five.

The accompanying photographs on this page show how this shunt is made.

What we want is a series of curves showing how the plate current varies as we change the C voltage while we maintain the B voltage constant. Such curves are known as I_p-E_g curves, I_p standing for plate current and E_g for grid voltage. Specimen curves are shown in Fig. 3. We may plot these curves as we take the data and record them in a book too. The curve should be a smooth one, otherwise an incorrect reading has been taken.

EFFECT OF PLATE VOLTAGE

THE next thing is to observe the effect of varying the plate voltage while we maintain the C bias at given values, say negative 9, 7.5, 4.5, 3, 0, and several positive values. The plate voltage may be varied in 22.5-volt steps, or less.

Now, from these two sets of data, all of the important tube factors may be found, *viz.*, amplification factor, plate impedance, mutual conductance, d.c. resistance, power amplification, and voltage amplification.

We may see from an inspection of the curves obtained that increasing the plate voltage increases the plate current, and that changes in the grid voltage also produce variations in the plate current. In other words, there are two factors that control the plate current—the plate voltage and the grid voltage. For a number of reasons, the grid voltage is more effective, and it is by virtue of this fact that the tube performs its multitudinous functions.

The amplification factor of a tube, usually designated as "Mu," is a measure of the relative effect of changing the grid voltage compared to changes in the plate voltage. It varies from about 3 for a 171 tube to about 30 for a Western Electric V tube. Its actual numerical value depends upon the construction of the tube and is practically constant over wide variations in plate or grid voltages.

RADIO BROADCAST Photograph

THE SIMPLICITY OF THE SHUNT

Is clearly shown in this illustration. It consists of a small resistance suitably mounted for connection to the meter terminals

To calculate the amplification factor from the curves showing how the plate and grid voltages control plate current, is not difficult. We note in Fig. 3 that, with 90 volts on the plate E_p-90, changing the grid from negative 5 to positive 5 changes the plate current from 3 to 13 mils. We put down our data thus:

Grid voltage	Plate current
−5	3
+5	13
10 volts change	10 mils. change

We have varied the grid voltage about a mean or average value of zero, that is, five volts below and five volts above zero. Looking at the E_p-I_p curves in Fig. 4, pick out the one which was made at zero grid voltage, and put down the data as follows:

Plate voltage	Plate current
126	13
48	3
78 volts change	10 mils. change

Now we are able to arrive at the amplification factor (Mu) from the following formula:

$$Mu = \frac{\text{change in plate voltage}}{\text{change in grid voltage}} = \frac{78}{10} = 7.8$$

From the data above we may calculate all of the other important factors. For example, the plate impedance is defined as follows:

$$R_p = \frac{\text{change in plate voltage}}{\text{change in plate current}}$$

Remembering that a milliampere is one thousandth of an ampere, and that we must use volts, amperes, and ohms when calculating, we get:

$$R_p = \frac{78}{.010} = 7800 \text{ ohms}$$

The d.c. resistance of the tube is altogether different from this value since, by Ohm's Law, it is simply the ratio of the voltage and the current reading at a particular point. Thus, from Fig. 5:

$$R.\ d.c. = \frac{126}{.0124} = 10{,}150 \text{ ohms}$$

The a.c. resistance is found out by the following formula:

$$R.\ \bar{a}.c. = \frac{126 - 30}{.0124} = 7{,}730 \text{ ohms}$$

The d.c. resistance is not indicative of what the tube will prove to be, either as an amplifier, a detector, or an oscillator. It merely proves that the filament still has a supply of electrons, and that the elements are properly connected to their respective lead-in wires.

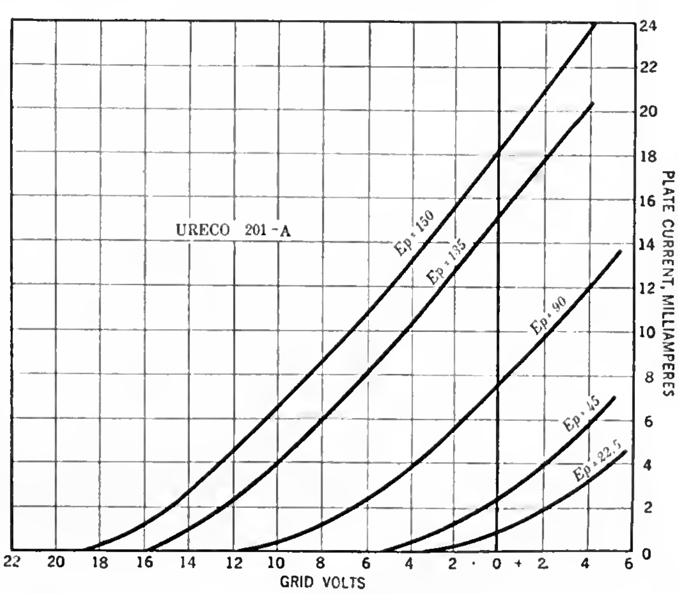


FIG. 3

These curves are from a 201-A tube and are what is known as "E_g-I_p" curves, that is, "grid-voltage plate-current" curves. They indicate how the plate current varies with changes in grid voltage

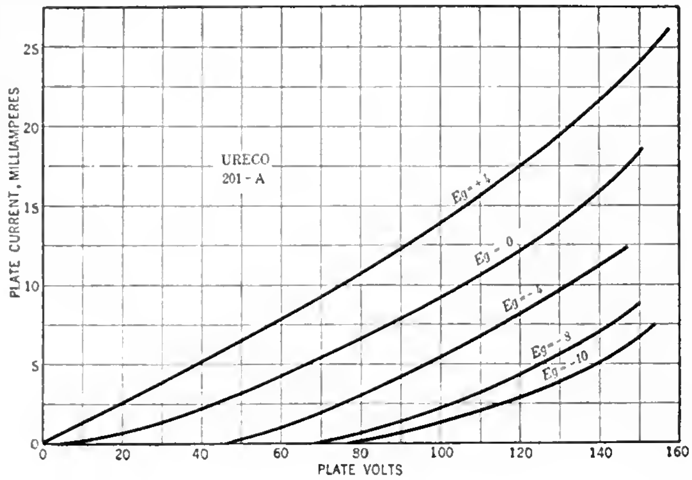


FIG. 4

Plate-voltage plate-current curves, or, as the tube technician would say "E_p-I_p" curves. From the data plotted here and in Fig. 3, all of the important tube constant may be calculated

RADIO BROADCAST Photograph

SOME DELICATE WESTON METERS

These are standard meters and naturally are more expensive than those used by the average radio fan. These meters, although of the d. c. type, may be used for a. c. by using them in conjunction with thermo-couples, two of which are shown in front of the meters

MUTUAL CONDUCTANCE CALCULATION

THE mutual conductance of a tube is an expression for the effectiveness of the grid voltage in controlling the plate current. It may be obtained from the E_g-I_p curves since this factor is defined as:

$$G_m = \frac{\text{plate current change}}{\text{grid voltage change}}$$

and since, in the case above, we found that ten milliamperes change resulted from shifting the grid voltage ten volts, we have:

$$G_m = \frac{.010}{10} = .001 \text{ mho, or } 1000 \text{ micromhos}$$

The following table will aid in keeping the units straight for the above series of calculations:

.1 milliampere	=	.0001 ampere
1.0 "	=	.001 "
10.0 milliamperes	=	.01 "
100.0 "	=	.1 "
1000.0 "	=	1. "

Now let us assemble our data and see if we cannot work out a system by which we may arrive at the important factors quickly. Our procedure in which any other values of plate and grid voltages may be used may be as follows:

1. Set plate voltage at 90.
2. Read plate current at E_g = positive 3.
3. Set E_g = negative 3 and read plate current.
4. Divide plate current change by grid voltage change (here it is 6 volts). This gives the mutual conductance at an average of zero grid voltage.
5. Bring plate current back to what we read at positive 3 by increasing the plate voltage.
6. Divide the plate voltage change by the plate current change. This is the plate impedance.
7. Divide the plate voltage change by the grid voltage change (6 again). This is the amplification factor.

There is an important relation between the amplification factor and the plate impedance. From our expressions given above but here set down in our short hand language,

$$\mu = \frac{E_p}{E_g} \cdot R_p = \frac{E_p}{I_p} ; G_m = \frac{I_p}{E_g}$$

we may operate by simple algebra. Let us divide the amplification factor by the plate impedance:

$$\frac{u}{R_p} = \frac{E_p}{E_g} \div \frac{E_p}{I_p} = \frac{E_p}{E_g} \times \frac{I_p}{E_p} = \frac{I_p}{E_g} = G_m$$

whence we see that the mutual conductance is the ratio between the amplification factor and the plate impedance. Within the limits of error in measuring the respective currents and voltage —and providing one only uses values on the straight parts of curves—the value obtained by this division will check that obtained from the curves.

There are several important points to be considered in measuring tube constants. It must be remembered that the factors vary at each point on the various curves. For each value of grid voltage and plate voltage, there is a value of plate impedance, and amplification constant, although the latter does not change

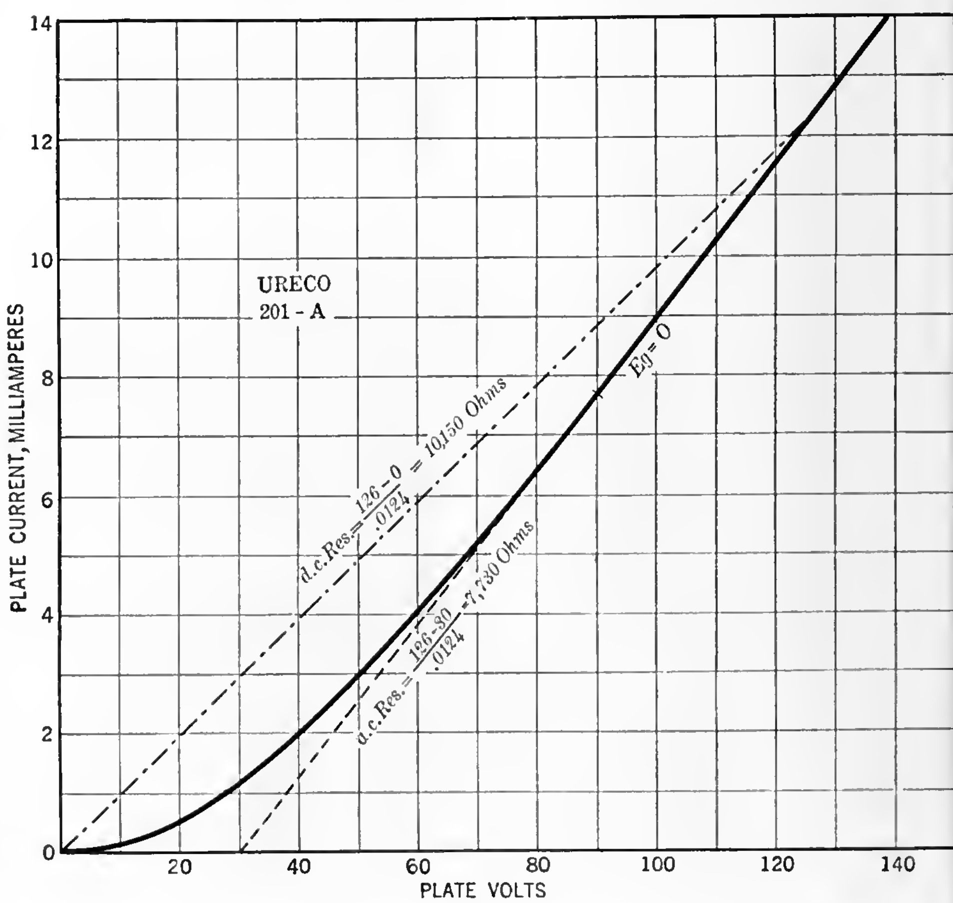


FIG. 5

This diagram of an "E_p-I_p" curve shows the difference between the a. c. "impedance" and the d. c. "resistance." The d. c. resistance is merely the plate voltage divided by the plate current, and may be represented by the reciprocal of the line joining the origin and the point under consideration. The a. c. impedance is the reciprocal of the slope of the curve much. This means that the mutual conductance varies with each change in voltage, and to state that a tube has a mutual conductance of 1000 means nothing whatever unless the conditions are given.

TYPE	EP	EG	A. C. RP	IP	D. C. RP	WHERE D. C.=A. C.	K
199	90	−4.5	18,500	2.4	37,500	90 Ep+3 Eg	2.0
201-A	90	−4.5	11,000	3.0	30,000	90 Ep+2 Eg	2.7
112	135	−9.0	5,500	6.3	21,400	135 Ep—6 Eg	3.9

TYPE	AVERAGE K.	MAX. K	MIN. K	TUBES TESTED
199	2.0	2.14	1.93	5
201-A	2.7	2.9	2.61	3
112	3.9	4.5	3.23	5

The question naturally arises under what conditions tubes should be measured.

There seems to be great divergence of opinion on this subject and each manufacturer of tubes and of tube testers seems to have his own ideas. At the present moment it is worth while to state that the R. C. A. and the Bell Telephone Laboratories measure tubes under the conditions at which they ordinarily work, *e.g.*, 199 and 201-A tubes with 90 volts on the plate and negative 4.5 volts on the grid.

There is another interesting point. We have shown that the d.c. resistance and the impedance differ. Now, if they differed by a constant amount, we could rig up a meter that would read plate current and at a given plate voltage would give us the impedance directly. Fig. 5 shows the geometrical relation between the impedance and the resistance.

It is true that for any value of impedance there is a set of conditions—grid and plate voltage—that will give a d.c. resistance equal to it, and over a certain range of conditions the d.c. resistance may be divided by a constant to give the impedance. For all practical purposes, *i.e.*, to tell a good tube from a bad one, and to actually measure the factors to a certain degree of accuracy, this method is entirely satisfactory. For example, the values in the accompanying table will be found to hold approximately. The actual variations from these values are also given.

DATA FOR CURVES FOR VARIOUS TYPES OF TUBES OBTAINED IN THE RADIO BROADCAST LABORATORY

199 (R. C. A. UX-199)

Ep	Ip @—8 Eg	Ip @—4 Eg	Ip @ 0 Eg	Ip @+4 Eg
22.5	0	0	.5	1.4
45	0	.5	1.5	2.7
67.5	.55	1.5	2.68	3.8
90	1.5	2.64	3.7	4.3

201-A (Ureco UV-201-A)

Ep	Ip @—10 Eg	Ip @—8 Eg	Ip @—4 Eg	Ip @—0 Eg	Ip @+4 Eg
22.5	0	0	0	.72	3.2
45	0	0	.5	2.5	5.8
90	.55	1.3	4.0	7.7	11.9
135	4.3	6.2	10.3	14.8	20.5
150	6.5	8.6	13.0	18.5	24.0

112 (CeCo UX-112)

Ep	Ip @—25 Eg	Ip @—15 Eg	Ip @—10 Eg	Ip @—5 Eg
45	0	0	0	.12
90	0	0	.5	4.3
135	0	.9	4.9	13.4
150	.1	2.2	8.2	19.0
180	.1	4.4	11.8	23.0

210 (R. C. A. UX-210)

Ep	Ip @—25 Eg	Ip @—15 Eg	Ip @—10 Eg	Ip @—0 Eg
90	—	—	—	7
135	—	—	—	15
150	.1	1.1	4.1	19
190	.6	6.0	11.0	28
252	4.5	16.0	24.0	42

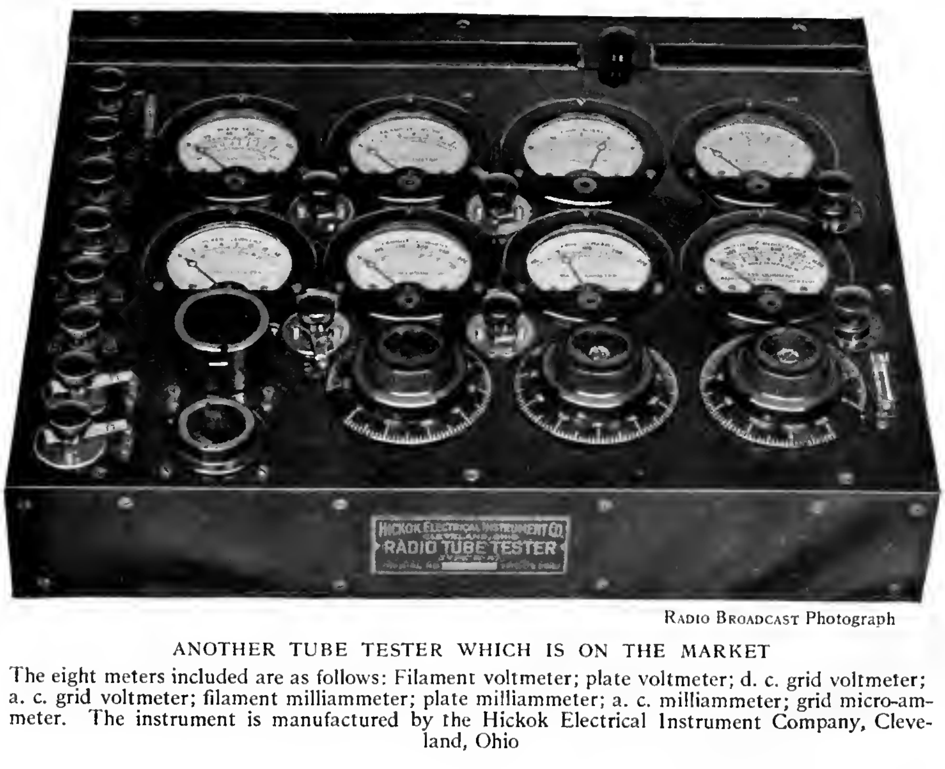
171 (R. C. A. UX-171)

Ep	Ip @—40.5 Eg	Ip @—33 Eg	Ip @—16.5 Eg	Ip @—4.5 Eg	Ip @—27 Eg
45	—	—	—	4	—
65	—	—	—	12	—
75	—	—	3	—	—
90	—	—	—	25	—
100	—	—	12.5	31	3
115	—	2	—	—	—
135	1.5	7	33.0	—	16.5
150	6.0	15	—	—	25.0
180	19.0	31	—	—	41.0
200	31.5	—	—	—	—

Whatever the methods of testing, it must be borne in mind that the computations outlined in this article are correct only over limited sections of the curves. This implies that small changes in grid and plate voltages are to be used to get plate impedance, amplification factor, and mutual conductance. In the Laboratory a 1000-cycle note is used on the grid with a maximum voltage swing of 0.8 volts, and the impedance is measured exactly as any other impedance, *i.e.*, in a bridge circuit.

The fact remains, however, that with a volt-meter and a milliameter one can measure all of the important tube constants. It can be ascertained how the impedance of tubes varies with conditions so that one may engineer his other equipment accordingly, and using the formulas given in the April RADIO BROADCAST, one can calculate the power output in watts obtainable from tubes as well as the gain in voltage in both radio- and audio-frequency amplifiers.

Those who wish tube curves may plot the data obtained from the table on this page which represents typical data on tubes now obtainable.



RADIO BROADCAST Photograph

ANOTHER TUBE TESTER WHICH IS ON THE MARKET

The eight meters included are as follows: Filament voltmeter; plate voltmeter; d. c. grid voltmeter; a. c. grid voltmeter; filament milliammeter; plate milliammeter; a. c. milliammeter; grid micro-ammeter. The instrument is manufactured by the Hickok Electrical Instrument Company, Cleveland, Ohio

Afire At Sea

A Short Chapter From War History—The Chronology of an SOS Call Which Brought Help to the Crew of a Blazing Merchant Vessel

By WALTER MEADE WILLIAMS

THE important part that radio played in the conduct and successful termination of the last war has long been recognized, and many are the stories that have been told of the experiences of the radio men who were active in this branch of the service during those years. Among these is my own story of the destruction by fire of the steamship *City of Wilmington* off Nova Scotia, on April 13, 1918. At that time I was senior operator of the *Wilmington* and on the particular occasion of which I write, we were just starting out from this country with an inflammable cargo for France, escorted by the usual convoy.

There was little premonition of danger in my mind as we picked our way out of the harbor at Wilmington, North Carolina, for I am not superstitious, and I stubbornly refused to sympathize with many of the forty men who comprised our crew when they expressed a vague fear that the boiler trouble, which had suddenly set in, was in some way connected with the date—the thirteenth. However, the boiler trouble did become so severe that the captain of the convoy ordered us to "make" Halifax rather than pass through the war zone in a disabled condition, and so we left the convoy and turned our bow back toward the American shore. In a short time I was in communication with the radio station at Halifax advising them of our return for repairs, little realizing as I pounded at my key, that before many hours were up I should be startling the ether with an sos call.

About eight o'clock, as I sat reading in the operators' cabin, I heard the fire bells ringing but little thought that there was anything seriously amiss. I woke up one of the gun crew who was asleep in the radio room and told him that the bell had just been rung for fire drill. He soon disappeared and I settled myself down comfortably to read again. Suddenly the door was thrown open and the second operator informed me that the ship had caught fire. "Hurry," he said, "there won't be much left of this ship in a few minutes." Considering the nature of our cargo, this latter statement seems to me now to have been fully justified.

I jumped to my key, and seeing the captain approaching with our bearings scribbled down on a rough piece of paper, I shouted to the other operator to fetch my life belt and overcoat.

"Send out an sos," shouted the captain, "bearings 42°, 38′ N; 58°, 18′ W. Tell them we're ablaze," he added.

Sooner done than said almost, and in a very short time I received three answers. The nearest was from Sable Island. Another from a United States cruiser, while the third came from a Danish ship. They all persisted in sending at once and time was lost in getting matters straightened out so that one should answer at a time.

"How long will it take you to reach us," I asked the Danish vessel. "We are a hundred miles away and probably will not reach you until three o'clock in the morning," was the cheerful reply. I found that the other ships were just as far away so our position was not altogether a bright one.

The captain told me that the fire was rapidly creeping toward the supply of fuel oil and that when it reached this point we could not last much longer.

By this time most of the crew had been ordered to the boats and the commander of the armed guard informed me that he too was about to abandon ship. "We will pick you up when you jump overboard if you won't come now," he told me.

After reporting to the captain, I again communicated with the operator on the cruiser, telling him of our condition and begging him to hurry.

By this time the deck was beginning to get really hot underfoot and smoke was pouring into my cabin. I looked anxiously outside and noted that all of the lifeboats had now been lowered and that only the captain remained on board. The flames were leaping skyward, and to anybody watching they would have formed a majestic spectacle, for tongues of flame now nearly reached the top of the foremast. Fire was sweeping both fore and aft and the heat was becoming more and more oppressive.

SURVIVORS ABOARD THE "MILLAIS" AFTER THE RESCUE

I called the Danish vessel and the cruiser once again. Both of them were coming now, but there was little consolation to be derived from my conversation except that they were hurrying toward us under forced steam.

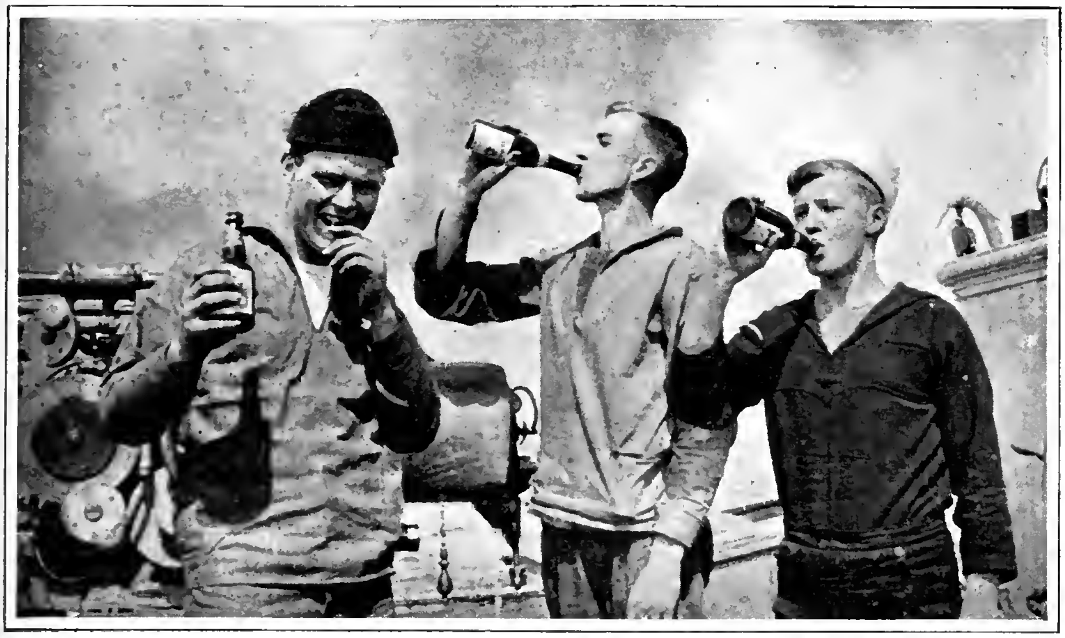
A loud voice, that of the captain's, boomed down my ear. "It's no use staying aboard any longer. Abandon ship," he ordered.

The radio room was just about unbearable by this time and I was only too glad to take the captain's advice. Once again I gave our position to the hurrying rescuers and wishing them a cheery "good night," we left the ship together, not before I had signalled, "me for the nearest boat," though, and then ran for it.

ADRIFT

WE SLID down ropes to a waiting boat and we were adrift, with the nearest help a hundred miles away.

It is not the most agreeable of pastimes to be cast adrift in a small boat, nor is it pleasing to watch the destruction of a fine



YO HO HO AND A BOTTLE OF NEAR BEER
Aboard the ill-fated *Wilmington* the afternoon before she was burned

vessel, especially if that vessel be one's home, so we were not in the best of spirits as we pulled away to a position perhaps a mile from the burning ship and lay watching the flames. As I watched, I saw the flames sweep aft and envelop the radio cabin. Then the shells, which we carried on board, started to make their presence known, and fragments of shrapnel tore through the air over our heads. We maneuvered our boats until they were out of range of the exploding shells, and as we did so I reflected somewhat dubiously on my possible chances of escape had I remained aboard for a few minutes more, not forgetting that the box of ammunition just behind the radio cabin would not have improved any such chances.

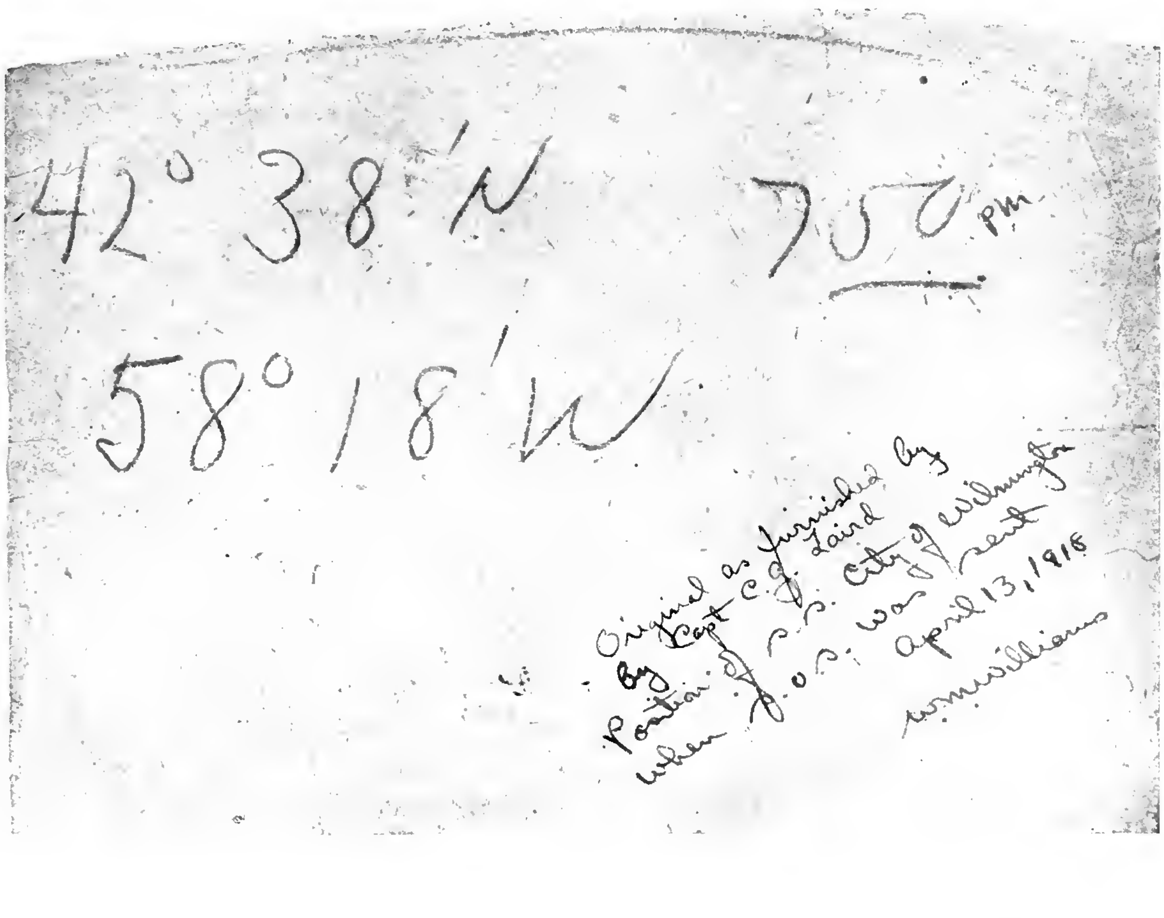
The water was smooth but there was a cold penetrating wind blowing and only the exploding shells prevented our drawing close to the conflagration to keep ourselves warm. The captain passed around cigars which he had saved at the last moment, and these were instrumental in cheering us up a great deal. At about two o'clock the next morning a ship's whistle was heard and we made every effort to attract her attention. We fired pistols in the air, we lit torches and shouted as loudly as we possibly could, but all to no avail, for the siren grew fainter and fainter and finally became inaudible. A fog had gathered during the night and we began to wonder how long it would take our rescuers to find us in this obscurity.

A little before dawn the captain proposed that we go back on board the ship as the flames had somewhat subsided, and fire the forward gun to attract the ships that were looking for us, as they were already overdue. It did not take us long to get back and we were able to find a few shells that had not exploded. The naval gun crew set to, and before long we were making enough noise to attract any ship within a considerable radius. Soon we heard an answering siren, followed by the dim outline of a vessel. Those aboard had heard our shots and were looking for us.

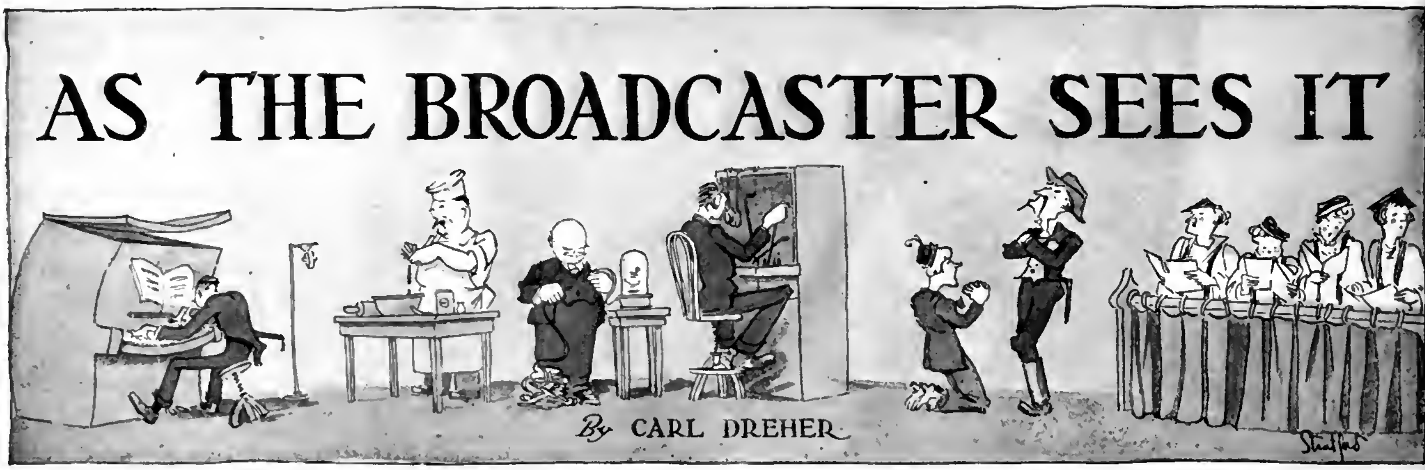
A cheer rent the air as we summoned up all the strength that remained to us to give it. The rescuer turned out to be the *Millais*, a Lamport and Holt boat —a Britisher—and no time was lost on our part in transferring.

As we took a parting look at the *Wilmington*, a shell was fired into her hull by the *Millais*, and we watched her sink to a watery grave, for floating wrecks are a menace to shipping and the *City of Wilmington* was too damaged to take in tow.

The Britisher was bound for Gibraltar and we were aboard her for ten days before we touched dry land. At Gibraltar we reported to the American Naval base and about a month later we sailed for home.



A REAL SOS
The bearings as they were handed to the author by the captain of the *Wilmington* when the SOS was sent out. The message was scrawled on a piece of brown wrapping paper



Drawings by Stuart Hay

Are Regular Features Good For Broadcasting?

AMONG the program managers who rule and sometimes ruin broadcasting in the U. S. A. and other countries bathed in the luminiferous ether, and, further, among the radio critics who harry and scourge the program directors aforementioned, some odium appears to attach to what are known as "regular features" on the air. The term as generally used is, of course, a misnomer. A feature is something important, outstanding. In broadcasting, the word is used to denote what would be an "act" in vaudeville, without regard to whether it is extraordinary or commonplace; the Blankety-Blank jazz orchestra broadcasting from the Hotel Inebriate, and the Philharmonic playing a Brahms symphony, are both "features" or "events." But, on this occasion, I am not seated at the typewriter for the purpose of cavilling at terminology. I desire to conduct a fair appraisal of "regular" or periodic broadcasts—those which recur every week at a certain time, and to distinguish between the good and the bad that is in them.

As I said above, some critics seem to object to these series as such. They would like to see a brand new program and program policy every week, one stunt following another with breathless variety. Such a project is impossible, and the prejudice against regularity is indiscriminating. What is objectionable is the recurrence of bad broadcasts, not of good and bad alike. We can stand the good ones every week, the bad are bad even once, although repetition, no doubt, aggravates the injury.

The public does not mind repetition of good things. I am not referring, now, to the considerable number of "hours" which have been on the air for years—the Eveready is an example—in which a definite effort is made to vary the program from week to week over a wide range. The principal elements of repetition in such cases are the name of the sponsor, the general nature of the program in such points as popular or special appeal, and the broadcasting character or personality of the stock company which puts the show on. But, the material itself being changed, the gravitational attraction which tends to draw all forms of entertainment down to monotony, is successfully resisted. Yet some dinner music programs show a similar longevity, although little attempt is made to shake them up, and the public appears to listen to them with pleasure. It is not an ecstatic pleasure, presumably, but then ecstasy interferes with digestion. In short, the purpose of the broadcast must be taken into account. If the purpose is unexciting, a certain degree of monotony is allowable.

To the broadcaster, "regular features" are life-savers. They are his guides and anchorages, the elements of stability in an all too uncertain existence. An orchestra is booked for every Tuesday night, after negotiations, and then the program rustlers know that, barring a strike or an earthquake, they have that hour filled for a while, anyway. The engineers, also, do not mind recurring "features" at all. Contrary to the general impression, a broadcaster does not walk into a hall, sniff the air, clap his hands twice, and walk out again in possession of all the facts concerning the acoustic characteristics of the place, down to all the details which the late Professor Sabine of Harvard University investigated so painstakingly. Preliminary surveys and tests are useful, but one still learns after the first time, and frequently gradual improvements in transmission are made over a period of months on a particular job. Then there is the factor of coöperation between the musicians and the technicians. Sometimes they fight more as they become better acquainted, but as a rule, an orchestra leader will do things, in the way of moving his men and modifying their playing, for operators he knows, that he would not do for strangers coming in with the same amplifiers and microphones. Sometimes this is carried so far that a conductor will demand that some particular operator or squad of operators, in whom he has confidence, be regularly assigned to his broadcasts, on the ground that he cannot conduct properly if the wrong man (wrong for that particular leader) is at the gain control. We may safely conclude that frequent broadcasts of the same material are beneficial technically, and hence somewhat more satisfactory to the public in that respect.

The argument that regular events make the work of the broadcaster easier is rather a weak one, inasmuch as the station is run for the public, not the staff. A more pertinent point is that a degree of regularity is inherent in nature, including the art of broadcasting. People expect it, as they expect the sun at dawn, the daily newspaper a few hours later, and a sermon on Sunday. For aeons, I, personally, have been listening to hotel orchestras play "My Heart at Thy Sweet Voice," from *Samson and Delilah*, and baritones intoning "The Road to Mandalay" and "Rolling Down to Rio." At least, it seems that long. And do you blame broadcasting for that? If you do, you are wrong; hotel orchestras and common baritones were plugging those pieces long before a grid, plate, and filament were stuck into a vacuum. Originality is rare, and the number of suitable tuneful pieces is limited. If we take to pushing regularity off the sidewalk, the banks will close, husbands will run away from their wives as one

"THEY FIGHT MORE AS THEY BECOME BETTER ACQUAINTED"

" PEOPLE EXPECT IT AS THEY EXPECT A SERMON ON SUNDAY "

man, the baseball schedule will be dislocated; it will be a job for the National Security League.

Well, let's be serious. Originality, we said, is rare. It is also precious. I am in sympathy with anyone who yells for it. But it must be the real thing, not one of the countless substitutes. The sort of variety and originality represented by broadcasting rattlesnakes, running a station twenty-four hours without a break, or reading the Bible from cover to cover on the air—may the patron saint of 1-B transmitters preserve us from it! I would a thousand times rather hear a good symphony orchestra on the air three times a week, even though it did play "Tod und Verklärung" twice in the season. When anything really interesting, astounding, or brilliant emerges from the sandy waste of mediocrities, I hope no one will try to shove it back under the surface if it happens to interfere with some solemn nonsense which was booked in 1921. I am not satisfied with radio, and I hope nobody else is. If we become satisfied, I trust better men will come along and boot us out of our jobs. But at the present stage it is not regularity that we must fight so much as aridity.

Technical Operation of Broadcasting Stations

II. The Heising Choke

SEVERAL alarmed broadcasters have inquired whether our statement in the July issue that 100 henrys is the right value for the voice choke in a telephone transmitter modulated by the Heising method, represents an invariable rule. The answer is that it does not. We will go into the matter in more detail.

As the article on *Modulation* (July), was supposed to cover all sizes of transmitters, I gave a value for this reactance high enough to suit the smaller sets. In general, the larger the transmitter, the smaller the choke required. If the low frequencies are not to be lost, the Heising choke must have a reactance, at low speech frequencies, which is high in comparison to the impedance of the modulator and oscillator banks. The latter figure is small for big sets and large for little ones. Hence the inverse relationship of transmitter power and size of modulator choke. Now, to take some numerical instances, suppose you have a transmitter with an UX-210 tube as modulator. The tube impedance is near 5000 ohms. An 100-henry choke, considered as a pure inductance, will present a reactance, at 50 cycles, of about 30,000 ohms ($X=\omega L=2\pi nL$, where X is the inductive reactance, and ω the angular velocity of the alternating current, which is equal to 2π, or about 6 times, the frequency n). Now suppose you have a 50-kw. set, or something on that order. There may be ten modulators in parallel, each with an impedance of 2000 ohms; together they represent only 200 ohms. If the choke is 10 henrys, the reactance at 50 cycles will be 3000 ohms, or 15 times that of the tube bank. In the case of the little set, the 100-henry choke has 6 times the impedance of the modulating tube, so that the margin is really better, with only a tenth of the inductance, in the case of the big set. It is a good idea to allow at least five times as much reactance in the choke as the joint impedance of the modulator tubes. That means around 100 henrys for the small transmitters, down to about 10 for the big ones, where, owing to the large current carrying capacity required, every added henry means money.

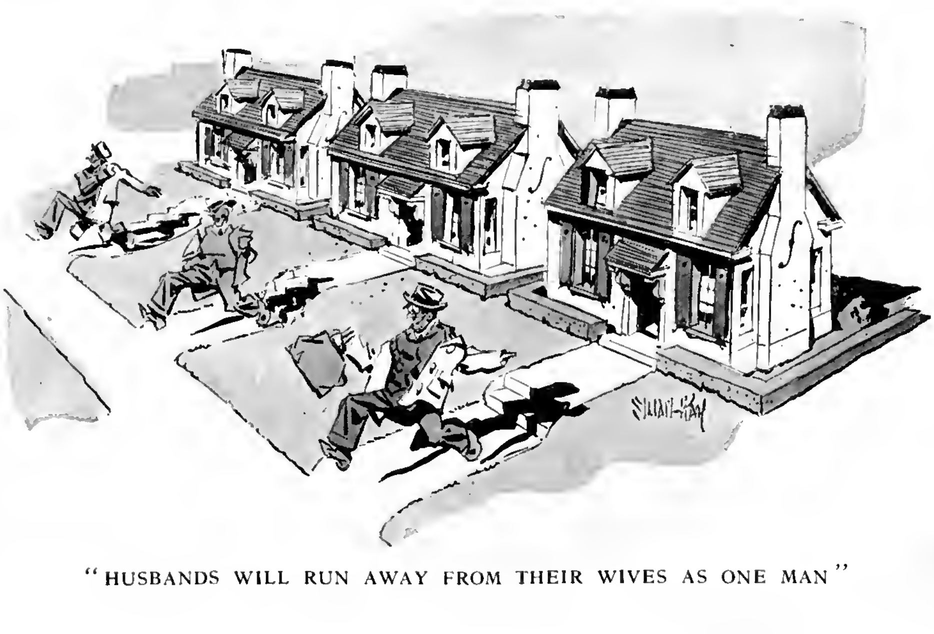
12. Modulator Plate Current Variation

MR. A. R. MARCY of WMAC, at Cazenovia, New York, writes us at length, giving suggestions as to what he would like to see in this department, which is exactly what we want to get from the professional broadcasters who read these articles. Mr. Marcy makes one point which invites further discussion. He says:

Your article on "Modulation" is really the one which inspired this writing. There seem to be real and concrete discrepancies between the opinions of radio eminenists as to just what happens (visibly) when the transmitter is being modulated. By this I mean the action of the modulator plate current meter. In July RADIO BROADCAST (page 246) you say that a d. c. meter in the modulator plate supply will not fluctuate. Now it is common knowledge that the modulator plate current meter of the WE 1-B transmitter varies continuously and is a rough check of the volume level. Mr. E. L. Nelson of the Bell Laboratories says in his article entitled, "Transmitting Equipment for Radio Telephone Broadcasting" (*Proc. I. R. E.*, October, 1924, p. 572): "When the equipment is in operation, the needle of the modulator plate meter swings at syllable frequency and affords a convenient although somewhat rough means of adjusting the input amplifier to give the proper volume level." Who is right? In my experience I've seen just one station where the modulator plate meter needle seemed inclined to make an effort to stay constant. The rest act similar to the needle of the volume indicator meter. Can we have some further information along this line?

This is a grave situation, since neither Mr. Nelson nor I can afford to lose our positions as "radio eminenists." But, as a matter of fact, we can both survive. We are not talking of the same things. My statement, it should be noted, was made in an illustrative paragraph, in an endeavor to differentiate clearly between the reading of a direct current instrument in the plate circuit of a modulator or amplifier, and the indication of an instrument like an oscillograph, capable of following the audio-frequency variations in the same circuit. That this distinction is not clear to all broadcasters and experts on electrical reproduction, is shown by the absurd controversy a few months ago about high quality amplifiers "modulating up" or "modulating down," i. e., whether a d. c. milliammeter in the plate of an ostensibly non-distorting tube should read higher or lower with audio input to the amplifier. The answer is, of course, that in a distortionless amplifier the plate milliammeters will remain nailed, fluctuating not at all while the modulation changes. Any change in the reading of these instruments spells distortion, and the more the pointers swing the worse the distortion will be. Whether they go up or down, when the output is loud, depends solely on whether the swing off the linear portion of the characteristic is at the low or the high end of the curve.

But, although I did not intend to oppose the ideal to the reality with the zeal of the reformer, Mr. Marcy has asked a shrewd and pertinent question, and we will discuss the problem from the practical standpoint. If *all* distortion is to be avoided, the modulators must fulfill the conditions of distortionless amplification, and the d. c. ammeter in the modulator plate feed will not vary at all with modulation. Such a



" HUSBANDS WILL RUN AWAY FROM THEIR WIVES AS ONE MAN " transmitter would possess unusual modulator capacity, and would cost considerably more money than the usual commercial set of its size. Mr. Nelson was writing about a very good, economically practicable set with two oscillators and two modulators, run with approximately equal energy supplied to each bank. Some fluctuation—just how much Mr. Nelson does not state—is considered allowable in the reading of the modulator plate meter. In other words, a compromise is made between quality and cost, which is rational enough, since the human ear does not detect slight distortion and, besides, few perfect receiving sets are as yet abstracting energy from the ether. The question is, Where shall the line be drawn? Kellogg, quoted in the article on *Modulation* which gave rise to the present discussion, evidently believes that the time has come to consider quality more, and cost of modulation, in tubes and power, less. Besides Kellogg and his associates, Conrad, Little, Weinberger, and other prominent broadcast transmitter engineers appear to be favoring ample modulator capacity in their latest installations. Theoretically, this trend is sound, for the progress of broadcasting on the technical side consists in reciprocal improvements in transmitters and receivers. As the receivers become better the transmitters must be improved, and then the receivers are further jacked up to take advantage of the progress in transmitter output. With the advent of power output tubes in receivers, an advance in transmitter modulation technique is a logical step. I should like to disclaim any marked originality in my discussion of *Modulation* in the July number. I have merely tried to sum up the latest results of the design engineers; like other active broadcasters, I am an operating engineer, but intelligent operation requires acquaintance with the problems and solutions of the development and design group in one's field. Like our correspondent, I have yet to see a broadcast transmitter in which the modulator plate meter remains absolutely constant, but I would add this: I have been connected with the job of running several transmitters, and the fluctuation of that meter has become progressively less from the earliest to the latest. Perhaps we should set an allowable limit of swing at syllable frequency —say 20 per cent. of the full reading of the meter, in the present state of the art. To me even this figure seems high, and I know of stations (on earth, not in heaven) where the swing is usually just appreciable when one looks closely at the needle of the plate modulator ammeter, and around 5 per cent. on normal peaks. If I were a listener with the musical ear of a Paderewski and a $500. receiver, I should be inclined to favor one of these products of the immaculate modulation, in voting for my favorite station, rather than those in which the modulator plate ammeter oscillates giddily all night long.

Abstracts of Technical Articles
II.

IN THIS department for September, under "Technical Operation of Broadcasting Stations," No. 10, there appeared an article on "Calculation of 'Gain'," in which the relation between the mile of standard cable and the numerical voltage amplification was discussed. This treatment was not quite complete, inasmuch as the mile of standard cable is not the only reference standard of transmission efficiency used in wire telephony, and is in fact being supplanted in commercial telephone practice by a new unit, called the "Transmission Unit," or T. U. The new unit differs only slightly from the mile of standard cable. To show the advantages of the T. U. system, we present the following abstract of:

"The Transmission Unit and Telephone Transmission Reference Systems,"

by W. H. Martin, of the Department of Development and Research, American Telephone & Telegraph Co., *Journal of the American Institute of Electrical Engineers*, Vol. XLIII, No. 6, June, 1924.

For some twenty years, the "mile of standard cable" has been used in telephone engineering in this country and abroad, for expressing the transmission efficiency of telephone circuits and equipment. With the advance of the art this unit has not been found entirely suitable, and the engineers of the Bell System have replaced it by a new standard, the "Transmission Unit." In comparing the two units, some consideration of methods of determining telephone efficiencies is first necessary.

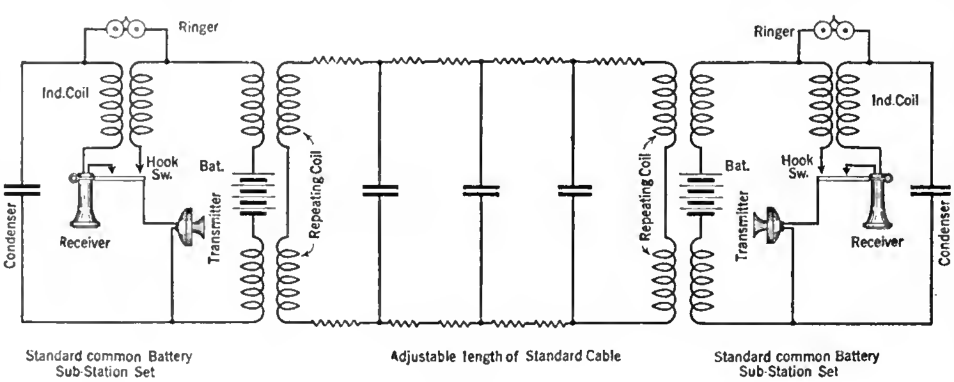


FIG. 1

A telephone system takes in sound energy at one terminal and reproduces it at the other terminal. Its efficiency as a transmission system may be expressed as the ratio of the sound power output to the sound power input. In commercial circuits this ratio is normally of the order of 0.0001 to 0.01.

The actual transmission, of course, is electrical in nature. The effect of any portion of the electrical circuit or the equipment therein may be expressed in terms of the variation which it produces in the ratio of the sound output of the system to the sound input. The over-all effect, and not merely the effect in a limited portion of the circuit, is what must be considered. Each portion of the circuit may be given an index expressing its effect on the sound output of the system. The effect of a number of such elements would then be found by multiplying the indices of the several elements. In practice, this is found to be a cumbersome method. But if the indices are expressed, instead, in terms of a *logarithmic* function of a ratio selected as a unit, then these indices may be *added* to give the resultant effect on the power ratio of the system. The "mile of standard cable" is such a logarithmic function, so in this respect the T. U., which is likewise a logarithmic function, merely meets a condition formerly recognized as essential.

The "transmission unit" is of such magnitude that two amounts of power differ by one transmission unit when they are in the ratio of $10^{.1}$. Any two amounts of power differ by N units when they are in the ratio of $10^{N(.1)}$. Hence we may write that the number of transmission units corresponding to the ratio of any two powers, P_1 and P_2, is

$$N = 10 \log_{10} \frac{P_1}{P_2} \qquad (1)$$

Equation (1) is the expression for the number of transmission units in terms of electrical power ratio.

Fig. 1 shows the "standard reference circuit" of telephone practice. The cable is an artificial line with resistance of 88 ohms and capacity of 0.054 microfarad per loop mile. Obviously with an increase in the amount of cable, the ratio of the sound output of the system to the input would decrease. Thus this circuit became the reference standard of the telephone plant. The reproduction obtained with a cable length of twenty miles was found practicable for local exchange service, within a city, and that corresponding to thirty miles for toll or inter-city service. Various changes in circuits under test were equated to miles of standard cable.

There then follows a mathematical demonstration showing that the attenuation of standard cable, per unit length, varies as the square root of the frequency of the current flowing in the circuit. Hence the "unit of standard cable" is unsuitable for use as a measure of efficiency in circuits whose behavior with respect to frequency differs markedly from that of standard cable. The new unit is independent of frequency. This makes it more general and constitutes one of its advantages. As it is based on a simple and universal mathematical relation, its use may be extended to fields allied to the telephone art, such as sound investigation. It is logarithmic in character, which is desirable in computation, as has been pointed out, and conforms also to the observation that the sensation of loudness in the ear is a logarithmic function of the energy of the sound. Finally, there is nothing revolutionary about the new unit, in that it differs by only about 6 per cent. from the "mile." The minimum sound power change detectable by the ear is of the order of one "mile" or transmission unit.

From *Transmission Circuits for Telephone Communication*, by K. S. Johnson (D. Van Nostrand Co.):

Multiply *miles* by 0.947 to obtain T. U.
Multiply T. U. " 1.056 " " *miles*

I would add the comment that for radio broadcast work, with the present uncontrollable variations in the ether path, the two units may be considered equivalent, but it is just as well to know something of adjustments in telephone standards such as that discussed in Mr. Martin's paper.

Memoirs of a Radio Engineer
XV.

ADVERTISEMENTS give the picture of an era better, sometimes, than many words. For some months I have been trying to describe the radio scene as it appeared to an amateur in the years before 1915. But the difference between that time and the present will probably show up more strikingly if we go back to some of the advertisements in the radio magazines of pre-broadcast days, and compare them with the ornate and opulent output of the agencies to-day. Quite at random, I have picked up an issue of *Modern Electrics*, that of July, 1913. Look through the advertising pages with me.

Then as now, the I. C. S. was threatening to raise your salary. Not, however, through radio. Clapp-Eastham was advertising a rotary spark gap, "The Blitzen." Why "Blitzen"? From the German, perhaps, meaning "lightning"? Quite possibly; it was before the war. Thordarson was selling "Junior Bell-Ringing Transformers." The Wm. J. Murdock Co. was an aristocratic radio supply house of the time. It advertised a loose coupler for the stupendous sum of $15.00. Most of the poor amateurs would have sold their entire stations for that sum. *Modern Electrics* was offering premiums with a subscription. For $1.50 you got the magazine and your choice of a "Little Hustler" motor, a "Tesla" magneto finished in red enamel, a Bleriot monoplane, or a medical coil. A 3-inch spark coil could be had for $13.15, from Hunt and McCree, who also offered $7.50 loose couplers for $1.93. The price cutter you shall have with you always. Wallace & Co. were selling a valve detector, later, I believe, adjudged an infringement on the De Forest audion, for $12.00, or $17.00 with storage battery. C. Brandes, Inc. was already selling head receivers at 111 Broadway. There were the usual number of schools urging young men to learn wireless telegraphy and see the world. There were also a great number of patent lawyers' advertisements. Then, as now, the lawyers made more money than the inventors. The Electro Importing Company spread itself over a full page. They had a "Commercial" detector stand for $3.75—Italian marble base, patent rotary sliding cup, felt bottom. What grandeur! But for the proletarians there was a "Universal" stand for $1.50, which the wretches no doubt neglected in order to build their own for 75 cents.

In the "Apparatus Exchange" department there were some comical items. An Iowan wanted to exchange "a new revolver, with 3-, inch barrel, 22 cal. break down, nickel plated, for Brandes 2000-ohm head set or 2-inch coil." The pleasures of slaughter had palled, evidently. Another hopeful offered to exchange 10 copies of Schnell's astronomy for key and sounder. Cameras, rifles, drawing outfits, musical instruments, and bound volumes of *Modern Electrics* were all in the market. Some had printing presses, scroll saws, phonographs, lathes, and post card collections, for which they wanted wireless apparatus. One fellow started off, "Will exchange good mail order business, paying 90 per cent. profit"—for anything you have. Some of the brethren, alas, appeared to have been robbing the local public service companies; a suspicious number of wattmeters and telephone ringers were being offered. Everything was "good" and "new"; nothing bad or old was on the market. Safety razors jostled Penzel B-Flat high pitched clarinets, which in turn bumped into "The Boy's Book of Model Aeroplanes," powerful toy motors, peroxide of lead detectors, acetylene post card projectors, and giant sounders. But the prize of the collection is the poor devil who advertised, "Will trade 1 artificial leg, cost $125, used very little, for any kind of electrical goods."

I'm not trying to spoof the readers; the ad is on page 429 of the July, 1913, issue of *Modern Electrics*.

Among the Broadcasters

WKRC

THE near-by photograph, ladies and gentlemen, is not a hotel lobby, but merely the reception room of WKRC, of the Kodel Radio Corporation. Although it isn't the lobby, it is in a hotel—the Alms of Cincinnati, and it is stated to occupy one half of the north wing on its floor. This reception room faces the solo studio, the orchestral studio, director's control room, and director's office of the station, so that visitors can see everything going on, through the windows. On the opening night, between six o'clock in the evening and six in the morning, when breakfast was served, five thousand visitors passed through the room and saw what there was to see, which is quite an expanse, as no one will deny. The two fellows standing looking into the studio are six feet tall, the representative of WKRC informs us, so that will give you an idea of the size of the room. (One of the gentlemen is also about three feet wide, apparently.)

If it were not for the Italian fresco wall finish, the studio staff could play indoor tennis in the reception room. That, it should be added, is our own bright comment, for which the publicity department of the station is not to blame.

WGY

AMONG other things, WGY is noted for its contemptuous treatment of the dear old carbon microphone. As far as the General Electric Schenectady station is concerned, carbon transmitters are passé. The WGY technicians would no more think of using carbon in their microphones than arsenic in their coffee, and presumably the same thing holds for their brethren at KOA and KGO. When it comes to microphones, they believe in nothing more solid than air—between the plates of a condenser transmitter. At WJZ, now, they are all for condensers in the studio, but when it comes to outside jobs they hem and haw, and take the freight elevator with carbon mikes in their hip pockets. The heroes at WGY go the whole hog. Occasionally, it appears, they pick up a church service of the Episcopalian persuasion, and have to use as many as eight microphones to do the job properly. And they use condensers, each with its two-stage amplifier. Three transmitters are mounted in the chancel, for the organ and choir, the latter being on both sides of the chancel. There is one at the altar and one at the lectern, for the rector conducts part of the service at these points, as well as one in the pulpit. Then a microphone is required in the auditorium or body of the church to pick up the congregational singing, and the chimes in the belfry get Number Eight. The remote control operator swings in the various transmitters according to his best judgment, as the service proceeds.

I suggest that Messrs. Sadenwater and Purcell, the engineering fellows in charge, endow a home for superannuated broadcasters and name it after the inventor of the condenser telephone transmitter.

WTAM-WEAR

BY PURCHASING station WEAR of the Goodyear Tire and Rubber Company, and combining it with its station WTAM, the Willard Storage Battery Company has secured full time on the 770.7-kc. (389-meter) wave in Cleveland. The program and operating staffs have been consolidated and the studio headquarters moved to the former WEAR offices in the Union Trust Building.

The manager of the combined stations is H. K. Carpenter; L. W. Zimmerman is program director, and S. E. Leonard runs the operating end.

ALASKA

ACCORDING to Mr. F. W. Fickle, of Seattle, Alaska, a territory so far without the local blessings of broadcasting, is to have a station of its own. It will be located in Ketchikan, and the studios will be in the Hotel Sunset Manor. Five hundred watts will be radiated on a wavelength as yet unassigned. Since Alaska is virgin territory for broadcasting, no trouble should be encountered getting a wavelength. This should be a great comfort to the six hundred odd applicants for broadcast licenses in the States.

THE PALATIAL RECEPTION ROOM OF WKRC, CINCINNATI

He Gave a Lusty Voice to Radio

"The Regenerative Circuit Was Not an Invention, it Was a Discovery," says Edwin H. Armstrong. The Story of the Man Who Was Responsible for Regeneration, the Super-Heterodyne, and Super-Regeneration, Three of the Most Important Contributions to Radio Science

By MYRA MAY

IF YOU were asked to name the ten men who have contributed most to the progress of the twentieth century, you would unhesitatingly include the name of E. H. Armstrong in your list. To him is due the credit for having taken the feeble, piping voice of radio and transforming it into a lusty tenor that can be heard all over the world. Under his care the adolescent wireless grew to manhood and developed from a raw recruit into a grand opera singer.

At the age of twelve, Armstrong started out with the ambition to train the untamed radio, and so well has he realized his objective that at thirty-four, he is famous as the inventor of the regenerative, the super-heterodyne, and the super-regenerative circuits.

In appearance, he is tall with mild blue eyes, a bald head and the erect carriage of an army officer. He is ready to talk on anything but himself. To elicit such personal facts, you must consult the "old" members of the Radio Club who knew "Howard" when he was at college and was struggling to establish his claim to his regenerative circuit.

"I knew Howard back in 1911 when he first began his experiments," says George Eltz, head of the radio department of the Manhattan Electrical Supply Company and one of his cronies. "He never spoke of what he was doing and none of us presumed to try to find out. He had made so much more progress in radio than any of the rest of us, that we followed him blindly. What he did was right as far as we were concerned, and he was our arbiter on all questions of wireless. He was a senior at college the year I transferred from Stevens to Columbia, but although we rarely saw each other at school, we often met at the Club.

"I remember going to Howard's home in Yonkers, one day—I think it was about 1912—and having the greatest thrill of my life, for I heard Little Glace Bay station in Nova Scotia. Most of our spark sets were unable to exceed the record of fifty miles some one else had set, so I felt that I was present at an epoch-making event to hear that distance. At that time, long antennas were fashionable; the longer the antennas, the better we thought we could hear. Armstrong's antenna, therefore, was strung along an embankment one mile in each direction, and we used to gaze in mute envy at the thousands of feet of wire.

"We had still another reason for envy. Howard was the only boy in the club who had more than one tube. The rest of us were proud to own even one, but Howard had quite a collection with which he constantly experimented.

"At the top of the house, he had his radio room which is as full of junk to-day as it was in those college days when we used to stand over him, and wide-eyed, watch his experiments. To support his antenna, he built the tall mast which still stands in front of the house. That mast was a wonderful vantage point from which to see fires. When the alarm sounded in Yonkers, Howard would make a rush for his mast. He always was a remarkable climber and could hoist himself up its length in double quick time.

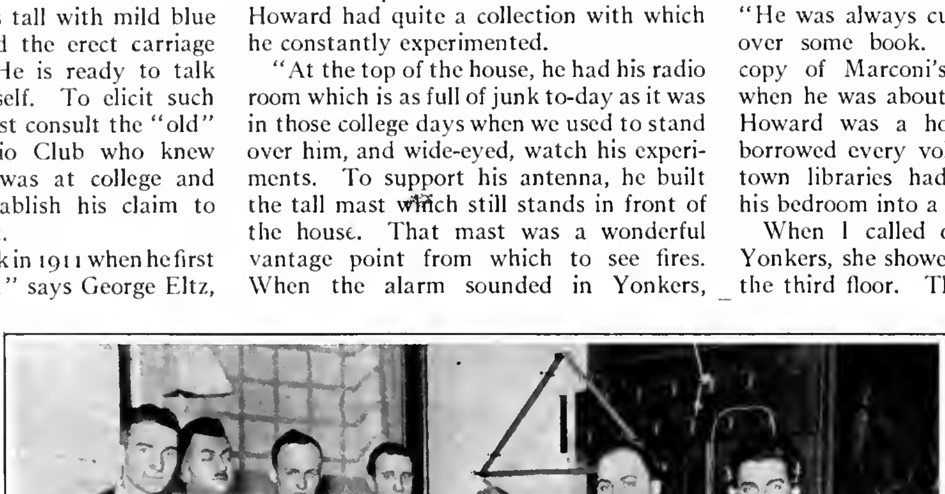
"He had a better understanding of wireless than any of the members, and all of us in the Radio Club of America were aware that he was far ahead of science, in his knowledge of the audion. The rest of us looked upon radio as a fascinating diversion to which we gave as much time as we could spare, but Howard devoted his whole life to it. Day and night he spent in the little room at the top of the house, where he experimented with his tubes and gadgets."

As a boy he was chiefly interested in reading.

"We couldn't make him go out and play with the other boys," his mother says. "He was always curled up, his head bent over some book. Someone gave him a copy of Marconi's treatises on wireless when he was about eleven, and after that Howard was a hopeless radio fan. He borrowed every volume on electricity the town libraries had, and he transformed his bedroom into a laboratory".

When I called on Mrs. Armstrong in Yonkers, she showed me the laboratory on the third floor. The room is undisturbed and just as it was when the boy used to make his experiments. A beautiful old secretary is piled high with weighty text books, a work table before the window is covered with early sets, variometers and bits of wire; even the floor is strewn with radio parts. In another corner, there is a heap of worn, discarded electric light bulbs while on the other side of the room, old storage batteries still stand guard over the models of armatures young Armstrong made when he was first in the grip of the electrical fever.

"By the time Howard was ready



A RADIO CLUB GROUP

Armstrong was closely associated with the Radio Club of America members when still at college, and when struggling to establish his regeneration claim. George J. Eltz, jr., one of the oldest members of the Radio Club, and now a director, says that in the old days the members were all jealous of Armstrong, for he was the only member of the club who possessed more than one tube. The above picture is a recent one of some of the Radio Club members. The gentleman with his left-hand thumb in a vest pocket is Louis Gerard Pacent, a director and committee member. To his immediate right is Thomas J. Styles, while to *his* right is George E. Burghard. Edwin H. Armstrong is a director of the Radio Club of America for high school," his mother continues, "he had read all the available English texts on wireless. At that time the German books were considered the finest so he elected German at school. It was no easy matter for a thirteen-year-old boy to master a new language and understand the technical features which are difficult even in a native tongue, but he persevered. He reached the stage when he could read the German as simply as the English. Whenever he has a plan he wants to carry out, he goes through with it, no matter how many obstacles may stand in his way.

"I remember when he was about thirteen, his little sister wanted a doll's house so he took some old boards and constructed the frame work of a cottage. He didn't know anything about carpentry but he worked until he had made a satisfactory job. Then he cut in the doors, windows, and even the stairway. After the little house was built, he added the crowning touch by putting in electric lights. Every room had its fixtures, which were controlled by switches.

HE ERECTS HIS FIRST ANTENNA

BY THE time he had progressed far enough into radio to want his own antenna, several years had elapsed. His sister, however, was still mindful of the doll's house so she helped construct the mast. Her part in the building operations was to send up on a pulley whatever tools Howard needed. That mast was about 170 feet high, but Howard climbed up and down with the utmost ease. The neighbors used to phone me to request that I keep my son away from the mast as it made them nervous to see him at such a perilous height.

"Howard was just out of college when he made his first invention. He used to stay up late into the night testing his discoveries. The policeman on our block says that the light shining from the third floor windows was his friendly signal when he used to patrol his beat. Since his marriage Howard no longer lives at home, but he still uses his laboratory and comes once or twice a week to work in it."

When Armstrong was twelve years old, Marconi sent the famous letter "S" across the Atlantic and the school boy up in Yonkers immediately evinced a keen interest. He

LEE DE FOREST TWENTY ONE YEARS AGO

This snap of Dr. Lee DeForest was taken long before anybody had thought of regeneration. It dates back to 1905, and was taken before the Boulder, Colorado, station. The names of Armstrong and De Forest are always mentioned when one begins to list those who made great contributions to radio

had been playing with electricity for more than a year but from that time on his future was all mapped out. He devoted his spare minutes from school to radio just as thousands of other boys were doing, but unlike these others, he was driven on by his determination to understand the miracles of radio. For the next eight years he continued studying his beloved subject with unabated zeal. It had become the biggest thing in his life.

By chance he secured a De Forest audion tube. Nobody understood its mechanism but young Armstrong made up his mind that he was going to discover the laws that governed its operation. Hitherto he had been mastering the theory of wireless in a general way; now he had a definite task to accomplish. As a means to an end, he threw himself wholeheartedly into his college course of electric engineering. At home he experimented with his audion and tried out new ideas which were beginning to occur to him. It was not until three years later that he felt he understood his subject thoroughly and at that time, Professor Pupin declared that Armstrong knew more about the audion than any one else in the world.

He had simply put his mind on what he wanted and gone after it.

"The regenerative circuit," he explains, "was not an invention, it was a discovery. While I was working with the De Forest audion, I found in the plate circuit high frequency oscillations of perhaps 500,000 cycles where I had expected spark tone of only 1000 cycles to the second. According to our text books, these high-frequency oscillations should not have been there. Much excited, I tuned up the rest of the circuit so that it would be resonant with those waves. I was amazed at my discovery. Whereas a moment before the signals had come in faint and barely audible, they were now clear and strong and could be heard all over the house.

"As I listened in, I heard San Francisco and Honolulu faintly, signaling to each other. The two stations were about two thousand miles apart, but they were compelled to repeat their messages frequently while I, more than 5000 miles away, could clearly hear the whole proceedings. I did not, however, jump to any immediate conclusions. For the next couple of months, I checked up my discovery until I was very certain that it was genuine."

Then Armstrong invited his teacher, Professor Pupin, to hear the new circuit in operation. Astonished at what his pupil had done, Pupin told the chief engineer at the American Telephone and Telegraph Company about the boy's exploit. The engineer could not grasp the magnitude of the discovery and it was not until the next year that he

FAR FROM THE MADDING CROWD

Yet unwilling to divorce himself from radio altogether for even his vacation period. Major and Mrs. Armstrong, on the sands at Palm Beach, listen to what the Florida ether has to offer with one of Mr. Armstrong's own "supers" came to investigate just what this boy Armstrong had really done. He found the boy had made good his claims, and realized at once what this revolutionary thing would mean for radio.

Armstrong hooked up the set and let his father hear Ireland and Honolulu. Then he asked for the money to take out a patent, but his father refused on the ground that inventions would interfere with his son's studies. The boy, however, believed that he had a really valuable discovery and applied to an uncle for the money to establish his exclusive rights to his circuit.

The uncle, instead, gave his nephew some advice which in later years proved more valuable than any amount of money could have been. He told the boy to make a drawing of his invention and have it witnessed and dated by a notary public.

DE FOREST OPPOSES PATENT RIGHTS

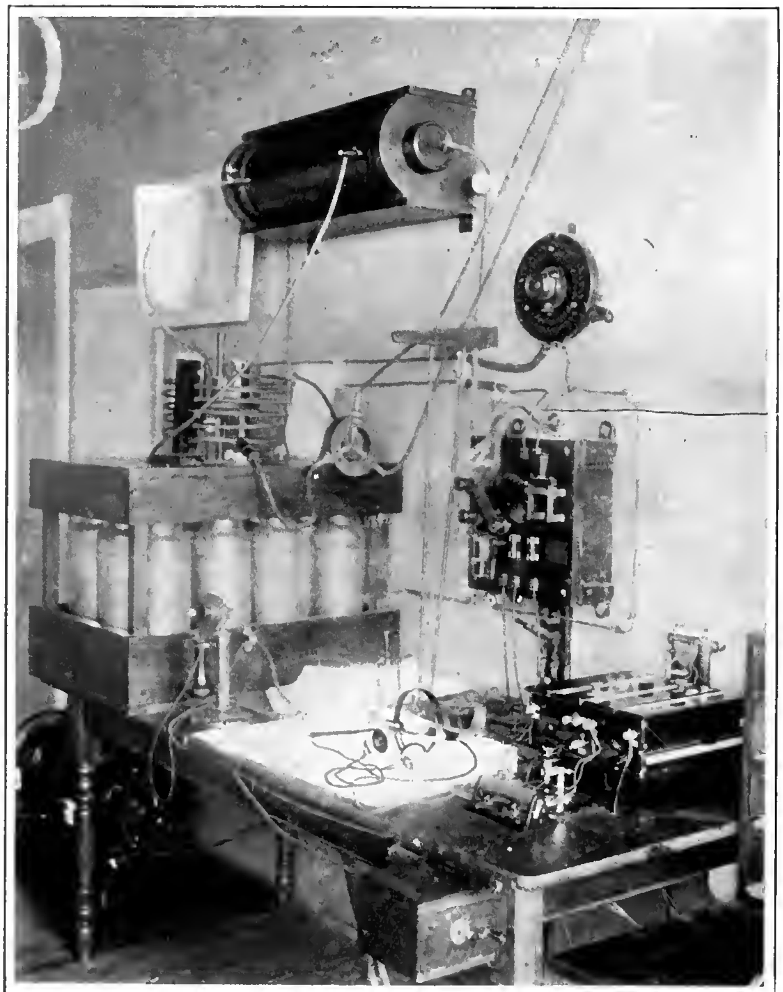
WHILE the patents for the discovery were pending, Armstrong became involved in a long tedious law suit. De Forest claimed that the regenerative circuit which was based on his audion, was an infringement of his patent. The boy, fresh from college, found himself in expensive litigation that cost thousands of dollars, dragged over six years, and that left him at its conclusion, a weary man.

The drawing of the circuit which his uncle had advised, figured largely in the case. In the interim, between the witnessing of the sketch and the trial, the notary had died. The other side brought signatures of the notary which were ornamented with fancy flourishes and curleycues whereas the signature on Armstrong's document was a plain simple piece of writing. Ugly rumors of forgery began to circulate, but Armstrong finally saved the day when he produced witnesses who proved that the notary had two signatures. The plain one which appeared on the circuit drawing, was the notary's ordinary handwriting and the highly ornate one was reserved for special occasions. The notary had evidently so lightly regarded the signing of the school boy's drawing that he had used the regular unembellished signature.

After that point had been cleared in Armstrong's favor, there yet remained the more important matter of priority. De Forest, the plaintiff, claimed that he had preceded Armstrong, whereupon the defendant brought his college friends into court and they testified to his having told them of the discovery. One boy even submitted a diary which in the year of 1912, bore the entry, "Armstrong told me he had a connection for intensifying sound."

To strengthen the case further, moreover, Armstrong rigged up a radio set which he brought into court and which he explained in simple, non-technical terms. During the day, he was engaged in the law suit while at night he constructed the sets with which he hoped to substantiate his claims. He was laboring under an immense financial, mental, and physical strain. No company was willing to buy his invention while the patent was opposed or until he had proven his rights, so he struggled on alone, finding the way more and more thorny. The case dragged on and then the United States entered the war. Armstrong's reputation was already established, so when he offered his services to the government, he was given the rank of captain and sent overseas as head of Radio Communication. His was the most important wireless work in the A. E. F. At first he was in England and later he was transferred to France where he associated with the biggest scientific figures in Europe, and was made a Chevalier of the Legion of Honor in recognition of his second invention, the super-heterodyne. During the war it was found that the Germans, who had radio stations about a mile or two apart, sent signals which our wireless operators were unable to pick up. These signals were no longer audible when our stations, ten miles away, tried to receive them. Of course it was of the utmost importance for this country to be able to intercept enemy messages, but their transmissions were on very short waves, somewhere in the neighborhood of 3,000,000 cycles a second. Armstrong's problem was to amplify these high frequency oscillations so that they could be heard in the American stations ten miles back.

The vacuum tubes constructed in the United States failed to solve this outstanding difficulty that confronted the A.E.F.," he relates. "We were unable to receive extremely weak signals of frequencies varying from about 500,000 to 3,000,000 cycles with an absolute minimum of adjustments to enable rapid change of wavelength. Round in England and Latour in France had produced aperiodic radio frequency amplifiers covering the band from 500,000 to 2,000,000 cycles. Their results had been accomplished by the use of vacuum tubes and transformers of minimum capacity.



AN EFFICIENT INSTALLATION, OLD STYLE

It is a standard United Wireless station. The receiver consisted of a crystal detector in conjunction with an "efficient" three-slide solenoid inductance. The transmitter was powered from a 10-inch spark coil. The discovery of regeneration played no little part in making obsolete such installations as that pictured. It is surprising, though, how much some persevering operators used to get from their sets before the advent of the tube

NECESSITY THE MOTHER OF INVENTION

WHEN the United States entered the war, the fact that it was necessary to produce extremely sensitive receivers for short wavelengths, and that tube capacity would prove a bar to a straightforward solution of the problem, was not known in this country. As a result, no attention was paid to the capacity in the type of the vacuum tube which was adopted, and while it met the requirements of the lower frequencies admirably, it was impossible to use it effectively for the frequencies of importance in the direction-finding service.

During the early part of 1918, through the courtesy and energy of General Ferrié and his staff, the Americans were supplied with apparatus of French manufacture.

It was apparent, however, that this source of supply could not be a permanent one and a solution of the problem became essential.

After much experimenting, the super-heterodyne was made for direction finding. It was Armstrong's first invention born of bitter need; the regenerative circuit had been the result of an amateur wireless operator's love of his work. The super-heterodyne was this wireless operator's reaction to necessity.

Harry Houck, who was Armstrong's sergeant in France, tells this story:

"The first super-heterodyne was developed under shell fire. They (Big Berthas) were bombing Paris and every few minutes another terrible explosion would shake our laboratory and add zest to our experiments. I had been working under a captain by the name of Armstrong for the past three months, and, while we conducted our research to the tune of exploding shells, I chatted with a mechanic about what a fine, straightforward chap this Armstrong was.

"'You know who he is?', the mechanic asked.

"Then for the first time, I learned that my superior officer was the Armstrong of regenerative circuit fame, the man who had been my secret idol since I was twelve years old. I could not believe that this unassuming Captain Armstrong was the famous man about whose inventions I had read so much. I had to be reassured by the men in the laboratory before I was convinced.

"The first set we made was a combination of parts from every type of radio in existence. We used old German apparatus that had been captured and sent to us for observation and we picked to pieces some of the American products also. Thus we gradually evolved our trial set. We sent it up to the front where it was an immediate success. From that time on, we intercepted German messages without difficulty. Every day brought new confirmation of the power of the super-heterodyne. We would hear that the Germans expected to attack a certain sector; we would decode a message from their air force; we would learn where they were massing their forces. Daily our set performed miracles, each of which was an exciting chapter in the story of the American Expeditionary Forces. Captures that formerly would have been outstanding events became such regular occurrences that we ceased to comment on them."

THE PHANTOM ZEPPELIN

CAPTAIN Armstrong became Major Armstrong, and he was made a Chevalier of the Legion of Honor, but he continued with unabated zeal to head the radio branch of the A.E.F. Part of his duties brought him in contact with airplane radio. He had to go up in the American planes that he might intercept the German messages which were sent between their Zeppelins and their ground stations.

On one occasion while Major Armstrong was up in the air, cruising around Paris, he and his pilot were startled by the sight of exploding shells dropping on the city below them. He was not equipped for aërial battle so he tried to locate the Zeppelins so that he could inform the American gunners below of their exact location. In vain he and the pilot sought some clue as to the whereabouts of the enemy machines.

"Those smart Germans must have made an invisible airship," the pilot said.

The invisible airship was wreaking more and more havoc. Buildings toppled, sirens whistled, shells exploded, and the Major could find no trace of the death-dealing "ship". It was not until Armstrong and his pilot returned to the hangar, that they learned the "invisible airship" was "Big Bertha" bombing Paris.

After the Armistice, American headquarters were moved to Spa, Belgium, to a house formerly occupied by Von Hindenburg. To keep in touch with the outside world, Major Armstrong set up a radio station in the cellar. He made a workable set out of the parts of a number of small damaged outfits. The very day that the new Spa station was in order, it was inaugurated by a message from the radio operator in Paris who explained that a cable for the Major had just arrived, and if he so desired, it could be transmitted by radio. The gist of the news was that the De Forest interests had reopened the legal fight in New York.

Armstrong was three thousand miles from home and his life's work was at stake. He reached home as soon as possible and resumed the long-fought battle. It dragged on until March, 1922, when a verdict in Armstrong's favor was at last handed down. Since then there have been additional legal engagements between the holders of the Armstrong patent and the De Forest interests. It is not, however, within the province of this article to go into the vagaries of the decisions and legal points involved.

During the experiments in court, with which he proved his case, he noticed the phenomena that led to the discovery of his super-regenerative circuit. It magnified sound enormously.

All three of his inventions, Armstrong sold to a large radio and electrical concern.

"Don't let the thought of money engross you; throw yourself into your work," he advises. "The best pay you can get is the satisfaction of a job well done, but society is so arranged that the man who has contributed happiness or comforts usually gets financially rewarded besides. Money comes to those who think little about the actual earning of the dollars and cents."

NORTH, SOUTH, EAST, WEST

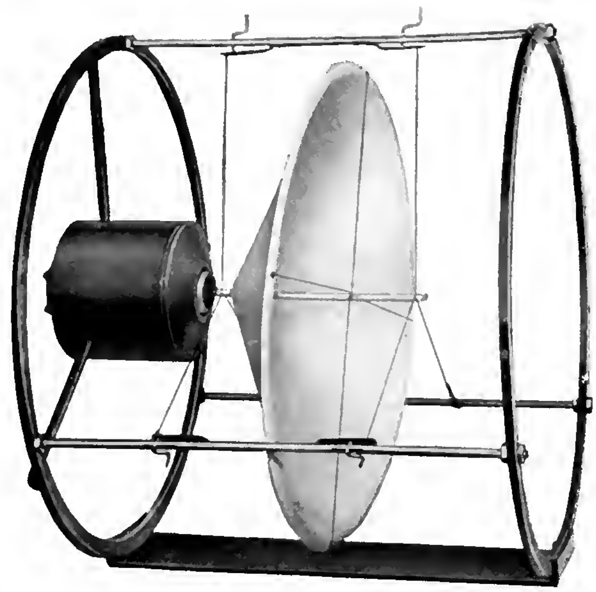
Wherever radio has been taken up, the regeneration discoveries have been incorporated in amateur constructed receivers. This picture shows an Argentinian amateur operating his home-made receiver. The gentleman is Mr. D. S. P. Acuna, one of the best known of Argentinian radio enthusiasts.

Cone Loud Speakers

A Radio Club of America Paper Which Tells of the Development of the Cone Type Loud Speaker—The Requirements of a Cone to Reproduce Equally the Whole Audio Frequency Range—Where to Look for Distortion When It Occurs

By C. L. FARRAND

President, Farrand Mfg. Co., Inc.



A FREE EDGE CONE DEVICE

In this instance the cone was mounted on a paper straw, and reinforced by silk threads from the straw to its periphery. Bobbin motions as large as one-eighth of an inch were sometimes noticed with this instrument

DEVICES used in the process of converting sound into electrical energy cannot always be used for the reverse process—to convert electrical energy into sound, that is. This is especially true in the case of the common carbon microphone. However, the condenser microphone, to cite one concrete example, is a very satisfactory converter of electrical energy into sound, provided the energy is not considerable. If an attempt be made with this device to obtain the same amplitude of sound as the original input (into the transmitter of a broadcasting station, for example), an electrical rupture will occur. This is due to the low efficiency of the device, and to the low insulation resistance made necessary by the very close spacing of the opposite plates of the condenser microphone. The conversion efficiency of these devices is very low, the electrical output being very small.

Certain types of microphones (better styled "pickups") may be reversed, providing the amplitude is already within the working limits.

For the true conversion of sound into electrical energy, or vice versa, three conditions are necessary. First, we must provide a surface in the wave front of the sound wave which will move in accordance with the sound wave; second, adapt this surface to actuate or control an electric or magnetic field; third, arrange the field so it can be utilized for the production of the necessary voice currents.

The construction of the field and its associated circuit presents but a small problem, while the construction of the moving surface and its supports presents many mechanical difficulties. A disc, secured at its edge, as in the form of the present day telephone, has the disadvantages of stresses in the metal permitting the center portion to deflect a relatively large amount while the edge is stationary. This gives rise to mechanical period in the diaphragm itself, which is ultimately imparted to the associated electrical system. In the development of the telephone it became evident that it would be desirous to have the surface of the diaphragm move integrally from its center to its edge, so a diaphragm of conical shape was resorted to.

The conical shape gives extreme rigidity to axial motion and provides a surface which moves as a plunger, and which is of small weight. Cone diaphragms were used in telephones and were sometimes used in connection with horns as loud speakers. The action of the diaphragm of a plunger was to change the volume of the air in the sound box and force a high amplitude sound wave from the orifice into the horn, while the old style diaphragm changed the volume of air in the sound box by flexing. The usual difficulties of sound box resonance were present, and the addition of the horn added certain resonant periods.

THE REQUIREMENTS OF A GOOD HORN

MUCH time and effort have been applied to the development of horn loud speakers for phonograph and radio purposes. Horns of small size have been made which cover only a small portion of the frequency range. A horn, to reproduce music successfully, should cover a frequency range of 50 cycles to 6000 or 8000 cycles. This can be partially accomplished by a horn of large size, *i. e.*, 6 or 8 feet in diameter and of about the same length. Horns of smaller size generally cover the upper range or the middle range, and depend upon internal resonance to develop the lower notes.

In order to approximate a reasonable range, several horns can sometimes be used in combination. One horn would be designed for the upper range while one or two horns would be designed to cover the middle and lower ranges. The results obtained from devices of this kind have been only partially satisfactory, as a great many resonant periods occur, which tend to accentuate or blur certain tones.

The conical diaphragm, when used in telephone sound boxes, presented different problems than when it was freely exposed to the surrounding air. Hopkins made a large step in this direction by evolving a practical conical diaphragm of sufficient size to produce a sound wave of magnitude comparable to the original sound, without the use of a horn. This was successfully used with a phonograph. Large diaphragms of this character will produce a sound wave of magnitude of a normal speaking voice with a small amplitude of motion. To produce the same magnitude of sound with a small diaphragm and horn, requires a much larger amplitude of motion and higher amplitude sound wave in the sound box. This high amplitude sound wave is passed out through the narrow neck-like opening of the horn and expanded along its walls and, as the area constantly increases, the amplitude of the wave decreases and ultimately passes to free air at approximately the same amplitude as the wave produced by the large diaphragm.

The author, while searching for a suitable loud speaker in connection with talking picture work and wireless telephone systems, and wishing to avoid the distortion of the horn, happened upon the Hopkins conical diaphragm, and combined it with suitable actuating electrical telephone mechanisms. The advantages of a diaphragm of this type for use as a loud speaker were investigated and developed. A conical diaphragm can be constructed so that it moves substantially as a plunger at sound frequencies. By so moving, it acts upon a large area and volume of air, and produces a high power sound wave of large amplitude, with slight motion.

It may be generally stated that the cone moves as a plunger at sound frequency. This, however, is not exactly the case. A cone of a given size will move as a plunger only if the frequency is sufficiently low. As the frequency is increased, the outer portion of the cone will tend to remain stationary, and, at extremely high frequencies, only the inner portion of the cone will move. If a cone is built several feet in diameter, the center portion of the cone will act at the higher frequencies, around 3000 to 5000 cycles, while, as the frequency is lowered, the active area of the cone will progressively increase. That is, at the lower tones, a larger portion of the cone will function. It was noticed in the use of larger cones that there was a greater tendency to reproduce the lower frequencies, or bass notes, and it seemed that there was a relation between the diameter of the cone and the length of the wave. It is not unreasonable to expect that a 10-foot sound wave can be better produced by a plunger which approximates that diameter than by one only a small fraction of that size. Such a diaphragm may be likened to an antenna, and acts as a radiator. With suitable proportion, it may approach an aperiodic radiator. By reducing the mass of the diaphragm and the elasticity of the suspension, and disassociating it from other mechanical portions of the system, it will approach the true conditions of aperiodicity. It is essential that the associated telephone movement does not upset this condition by having undue mass or elasticity. The mass and elasticity should be so proportioned that they do not appreciably reduce the natural damping of the diaphragm. A diaphragm of this character has an extremely large resistance to motion, which is due to the actual production of sound waves, and corresponds to the radiation resistance of an antenna system.

The relation between the size of the cone and the length of the sound wave corresponds somewhat to the relation between the size of the antenna and the length of the wave to be produced, that is, for efficient radiation, it is desirable to have an antenna length which is an appreciable fraction of the maximum wavelength to be radiated from the antenna system.

THE MOVING COIL SYSTEM

THE moving coil telephone is ideal for the purpose of producing a highly damped radiator, as the mass of the coil can be made very low, and the elasticity is only that of the diaphragm, which is extremely small.

The next in choice is the balanced armature telephone. The latter generally requires a reduction lever to reduce the amplitude motion of the armature to a lower motion for application to the apex of the conical diaphragm. A reduction ratio between 0.8 and 0.4 to 1.0 is generally satisfactory.

The moving coil system, with a large conical diaphragm, was developed commercially by the author in the form of the Phonetron of 1921, and used for both loud speaker and pickup purposes.

Fig. 3 is a photograph of one of the original Phonetrons, while Fig. 1 shows its constructional details. The conical diaphragm was supported at its edge by two clamping rings. To these two clamping rings, and located on the axis of the cone, was secured an electro-magnet, by means of a spider-like support. The electro-magnet was pot-like in shape, made of cast iron or steel with a central core of Norway iron, and provided with a field winding of No. 18 B. & S. wire (suitable for 6-volt operation), and thus produced a uni-directional annular field. A cylindrical bobbin of hard rubber was supported from the apex of the cone so as to move freely in the annular field without touching the metal portions of the magnet. This bobbin was wound with 0.002-inch diameter enameled wire, about 4500 turns, for use directly in the plate circuit of a vacuum tube. Fewer turns, together with a transformer, were sometimes used. The apex of the cone was stiffened by means of thin conical metal reinforcements. When used as a pickup, the construction was similar. The Phonetron pickups were installed in the original WJZ station in Newark, New Jersey, and were used there during the spring of 1922 with excellent results. Unfortunately the receiving equipment at that time did not permit the broadcast listener to appreciate the quality of transmission. A receiver utilizing a practically distortionless amplifier and Phonetron loud speaker was installed in the office of John V. L. Hogan in New York City. Tests were made between this receiving station and WJZ of Newark, and various comparisons of pickups and loud speakers were made. The amplifier used in connection with this early work was a resistance-coupled audio-frequency amplifier wherein only the alternating potential of the plate is supplied to the succeeding grid by means of a balancing battery, which balances the d. c. potential of the plate. This circuit is shown in Fig. 2. This amplifier, I believe, is due to Arnold of the Western Electric Company. It is very satisfactory for experimental purposes where it is desired to have distortionless amplification of all sound frequencies. Four resistance-coupled stages will give an amplification equivalent to about two stages of efficient transformer coupling. The new Radio Corporation and Cunningham power tubes, UX and CX 112, are satisfactory for this type amplifier. The purpose of making the resistance of the first stages larger is to decrease the operating voltage on the tube and to permit a smaller balancing battery which balances the operating voltage of the tube to be used. An amplifier of this kind will amplify from zero cycles to 25,000 cycles without distortion, there being no reactance, either capacitative or inductive, to introduce a frequency function. Figs. 4 and 6 are photographs of a battery balanced amplifier of this type built for laboratory purposes.

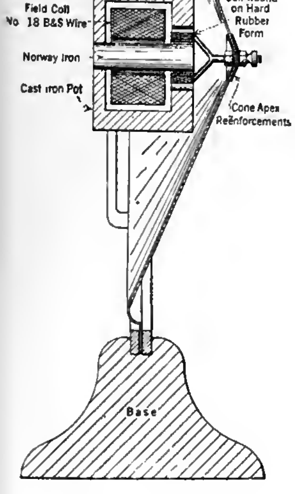


FIG. 1
The construction of the Phonetron, shown at the other lower corner of this page, is made clear by this diagram

CHOOSING PAPER FOR A CONE

IN THE development of the cone loud speaker, many different types of construction were tried. Various materials, including hard rubber, celluloid, wood, metals, paper, etc., were tried for the cone. A fibrous paper, not highly calendered, operates satisfactorily, and presents a good commercial solution. The thickness of the paper should be approximately one mil (.001″) for each inch of diameter, providing a soft finish paper is used; the thickness should be less if the paper is hard finish. The harder the finish of the paper, the greater will be found the tendency to depart from the cone shape, and undue stress will be set up in the paper, which will give rise to rattles, due to "tin-can" actions. The proportion of the altitude of the cone to its base can be gauged by the angle of the side of the cone to its axis. This should range between 30 degrees and 60 degrees. These values are approximate, and depend upon the size of the cone, and may be deviated from without affecting operation to any large extent.

The freedom of movement, of course, is hindered somewhat by the flexing of the paper at the edge. This flexing involves a loss of power which can be compared to hysteretic losses. Experiments were conducted to determine the amount of these losses and to lessen them. Sandpapering an annular portion at the edge of the cone, or substituting light flexible paper or other material, and castellating the paper edge, were tried. Where heavy paper was used, the above experiments improved the results, and were manifested by an increased clarity of treble. Complete freedom of the edge was obtained by suspension of the cone on silk thread. The photograph at the top of page 514 is of the free cone device. The cone was mounted on a paper straw, and reinforced by silk threads from the straw to its periphery. On one end of the straw was mounted a bobbin which floated in the annular field produced by the electro-magnet. The complete assembly was supported by threads. There was nothing to retard the axial motion of the bobbin; it floated freely in the sound wave, and motions as large as $\frac{1}{8}$th of an inch were sometimes noticed when used.

As this was done, it was found that the edge of the cone, due to the slowness of curvature, was not inclined to move integrally with the rest of the cone. This was overcome by making a circular trough-like portion at the edge, which reinforced it, and retained the circular form of the cone. A method nearly as effective is to reverse a small portion of the cone at the edge, making a V shape trough instead of the circular trough. The advantages of freeing the edge of the cone are so slight that operation can be equaled by suitable proportion, while the mechanical advantage of a supporting ring at the edge of the paper are apparent. The outer portion of the cone can be conveniently turned inward and the mass of the supporting rings and its supports materially reduced without affecting its operation.

Fig. 5 shows a photograph of a large cone speaker built in experimental form. The mechanism is substantially the same as that of the Phonetron, shown in Fig. 1, and consists of a floating coil supported from the apex of the cone and which floats in the annular, uni-directional magnetic field. The cone of this model was about four feet in diameter, and was made of pieces of wood cemented together. The

FIG. 3
In 1921, a moving coil system, with a large conical diaphragm, was developed. It was known as the Phonetron

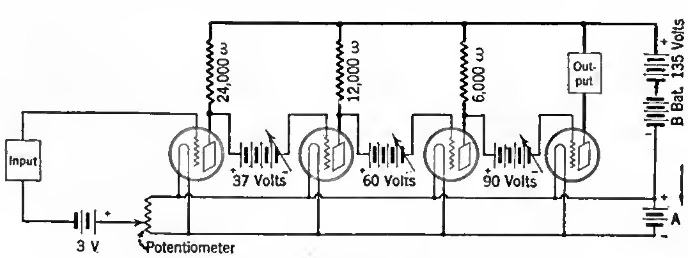


FIG. 2
This is the circuit diagram of the resistance-coupled amplifier used in a New York City location to pick up the signals from the old WJZ at Newark when comparisons of pickups and loud speakers were made in 1922

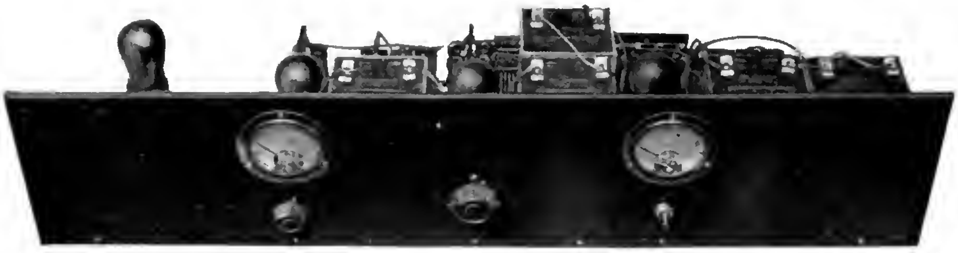


FIG. 4

A battery balanced amplifier as used in the experiments between New York and WJZ of Newark in 1922. It is a resistance-coupled affair wherein only the alternating potential of the plate is supplied to the succeeding grid by means of a balancing battery, which balances the d.c. potential of the plate

periphery of the cone was cemented to a ring of canvas which in turn was cemented to a square plywood board. The action of this device, as in the case of the Phonetron cone speaker, is as follows: The armature coil is drawn inward toward the field magnet when the voice current is in one direction, and forced outward from the magnet when the voice current reverses to the opposite direction. In this way, the force is applied between the apex of the cone and the heavy magnet pot without a system of mechanical levers.

The loud speaker, being the device which produces the sound, is generally blamed for all the deficiences of the receiving system, including those due to poor receiver, vacuum tubes, batteries, and at times, even the deficiencies of the broadcasting.

The better grade of receiver of to-day contains good audio transformers and is capable of producing good quality music with sufficient bass. It is, however, necessary that the batteries have voltage to supply sufficient power to the vacuum tubes. It is also necessary that the vacuum tubes have sufficient power capacity, *i. e.*, sufficient filament emission and normal filament brilliancy. The type UV-201-A and C-301-A tubes, when new and used with a 90-volt B battery, have sufficient emission and, therefore, power capacity, to permit faithful reproduction at only very moderate intensity. However, when the volume is increased with this combination, an accentuation of harmonics occurs, which are evidenced in a faithful speaker by nasal or rattling tones. An unfaithful reproducer will, however,

FIG. 5

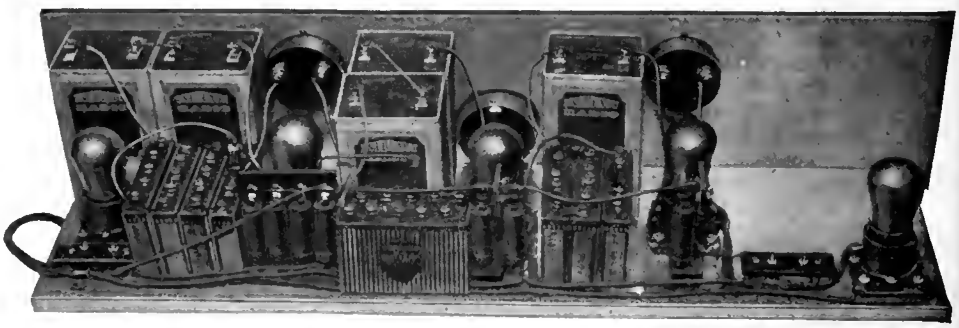
A large cone speaker built in experimental form. Its mechanism is not unlike that of the Phonetron shown on the previous page. The cone of this model was about four feet in diameter

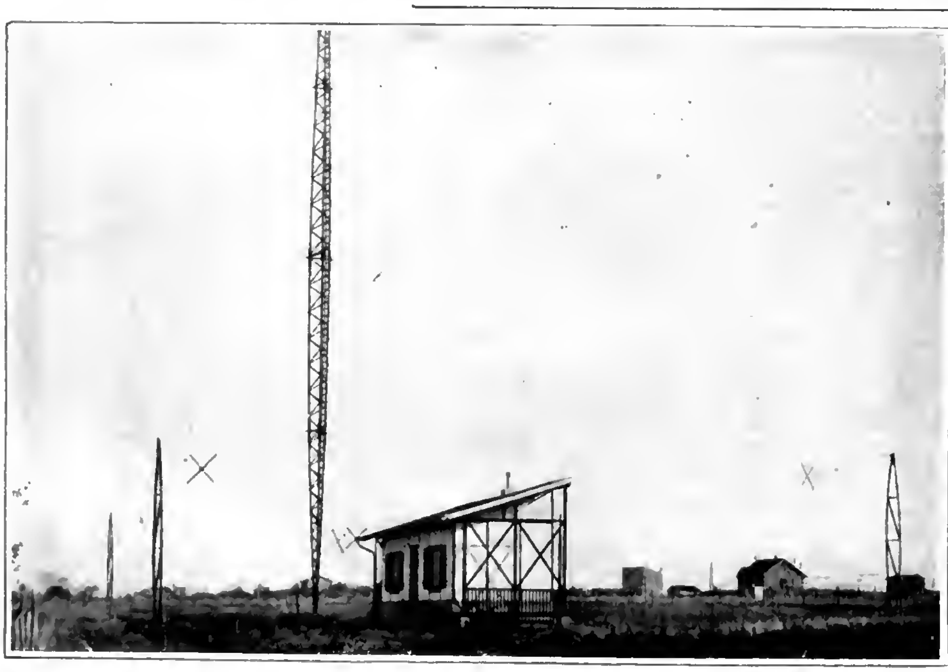
smooth these "rough edges" of the sound and give a more pleasing tone; this deceives the listener into believing that the more faithful speaker is faulty, whereas the facts are that the speaker is faithfully reproducing the voice which has been distorted by the vacuum tubes. This condition can be improved by an increase of plate voltage, which will lower the impedance of the tube and affect a greater transfer of the lower frequencies (when used with a transformer of given inductance), and will also permit the increased amplitude of the lower tones to be passed without distortion.

Super-heterodynes and sets of tuned radio frequency type utilizing regeneration have a tendency to change the tonal characteristics of the music or speech, when tuned. As the receiver is tuned to the maximum volume, an accentuation of the bass will be observed. This may cause all tones to become somewhat drumlike in nature with, at times, a complete loss of the treble. The tuning of a receiver should not change the tonal characteristics of the reception excepting that there is, however, a tendency of the human ear to respond more readily to louder sounds. In practically all radio reception of today, the magnitude of the treble is greater than the bass. This must not, however, be confused with the accentuation of bass due to regeneration as referred to above, when a partial or complete loss of treble occurs at the tuning point of maximum volume. A good receiver and speaker will reproduce throughout its tuning range the true relative value of bass and treble, the reduced bass on either side of the peak tuning point being due to the failure of the ear to notice the bass until it is sufficiently loud. The intensity of treble will not lessen at the tuning point of maximum volume, but the bass will sound louder.

FIG. 6

Below is shown another view of the balanced amplifier shown at the top of this page, and schematically in Fig. 2





A FRENCH AMATEUR SHORT WAVE STATION

Owned by *La T. S. F. Moderne*, a Parisian radio magazine. Its call is 8AÉ and when this station was erected, was using 1764-1499 kc. (180-200 meters). This view shows the antenna and counterpoise

RADIO BROADCAST

Metropolitan Shows Section

VOLUME IX | NUMBER 6

OCTOBER, 1926

A Special Section of Sixteen Pages, Devoted to a Presentation of the Advances in Complete Radio Receivers, Parts for the Set Constructor, and Accessories Which Can be Well Applied to Radio Sets Old and New, Together with an Article on How to Select Your 1927 Receiver.

Bringing the Radio Shows to the Country

THE offerings of the radio industry to the public for the 1927 season represent the soundest progress in the technical advancement of the art and the most substantial improvement in convenience and beauty of radio equipment of any year in the history of the industry. Visitors to the radio shows will marvel at the great simplification and refinement which is evidenced in the products of practically every manufacturer. To record this progress in lasting form, we devote this special section of the magazine. Prepared so far in advance, it is necessarily incomplete but we are grateful for the hearty coöperation of the industry which has made it possible.

While no printed description can hope to convey the show to its readers with the vividness of an actual visit to any one of the many shows to be held in all sections of the country during the next few months, we present the high lights of all the shows in a manner to be helpful to the set buyer. The special section which follows is an interpretative summary, not a catalog, of the progress of the art, as recorded by the show exhibits.

The two outstanding shows will naturally be those held at our two largest cities—the Third Annual Radio World's Fair, at Madison Square Garden, New York City, September 13th to 18th and the Fifth Annual Chicago Radio Show, Coliseum, October 11-17th, but enthusiasts in all sections of the country will be favored by comprehensive radio shows. The various show managements have so arranged their schedules that all the prominent manufacturers are enabled to ship their New York exhibits to each of the important shows in the country, assuring representative expositions in nearly a score of cities.

The principal shows scheduled are as follows: Akron Radio Show, September 15-18; Boston Radio Exposition, Mechanics Building, September 27-October 2; Third Annual Brooklyn Radio Exposition, 23rd Regiment Armory, October 30-November 6; Cleveland Radio Industries Exposition, Public Auditorium, September 20-26; Detroit Radio Show, Convention Hall, October 25-31; Second Annual Indianapolis Radio Exposition, State Fair Grounds, October 25-30; Los Angeles Radio Exposition, Ambassador Auditorium, September 5-11; Fourth Wisconsin Radio Exposition, Auditorium, Milwaukee, September 25-29; Northwest Radio Exposition, Kenwood Coliseum, September 27-October 2; Pittsburgh Radio Show, October 4-9; Pacific Northwest Radio Exposition, Public Auditorium, Portland, Oregon, September 20-25; Rochester Radio Show, Convention Hall, October 11-16; Second Southwest National Radio Show, New Coliseum, St. Louis, October 18-23; Pacific Radio Exposition, Civic Auditorium, San Francisco, August 21-28; Sioux Falls Radio Show, Coliseum, October 26-29; Omaha Radio Show, Auditorium, September 6-11.

It will be noted in the pages which follow that radio has at last progressed to the stage where each step forward is no longer heralded by a fanfare of excessive exaggeration. We now enter upon an era of sound improvement and steady refinement; the day of the revolutionary advance is a thing of the past. In our summary of what is presented at the radio shows, we describe the general trend of improvements which the show visitor will observe and how these improvements make for his greatly increased enjoyment of radio broadcast reception.

—THE EDITOR.

BEAUTY AND UTILITY COMBINED

The new Bosch "Cruiser" receiver, displayed in an unusual domestic setting. This is a two-control model with concentric knob for one-hand manipulation and typifies the sort of receiver offered the 1927 purchaser

What's New at the Radio Shows

A Pre-View of the New Receivers, Showing How the Radio Set, While Not Radically Different in Fundamental Circuit, Has Been Greatly Improved in a Hundred Little, Important Ways

BY EDGAR H. FELIX

NO MATTER what special features the visitor to the radio show may seek, he will find receivers which, apparently, have been designed to fit his particular needs.

The broadcast listener, who uses his radio for the musical entertainment and pleasure it gives him, will appreciate particularly the improvements in fidelity of reproduction attained by better audio coupling methods, shielding and power tubes, the flexible volume controls which do not introduce distortion, the many convenient single- and dual-tuning control receivers and the better power supply devices which reduce his maintenance duties to a minimum.

The long distance enthusiast will find his requirements met by a large selection of highly sensitive and selective receivers with as many as four stages of radio-frequency amplification, so precisely synchronized that single- and dual-control is feasible.

In deference to the lady of the house, manufacturers have incorporated significant advances in ease of control, beauty of appearance and simplicity of maintenance. Several makers are showing receivers having a single tuning control with an illuminated indicator, calibrated by stations or wavelengths, taking the guesswork and uncertainty out of tuning. She will also be pleased with the advances made in appearance, not only of the set cabinet itself, but in the complete sweep which has been made of unsightly accessories, such as B batteries, storage batteries, chargers, and loud speakers. In the better grade receivers, there is adequate space for every element necessary to the operation of the set.

The engineer, visiting the radio shows, will sigh with relief at the disappearance of the "revolutionary circuit" fairy tales which, in past years, have circulated at the beginning of each season. 1927 ushers in design improvements instead of discoveries in circuit design which are claimed to be millenial. The industry has finally settled down to making its product a better performer by painstaking design and workmanship rather than seeking the attainment of the impossible by a mere rearrangement of parts in new combinations.

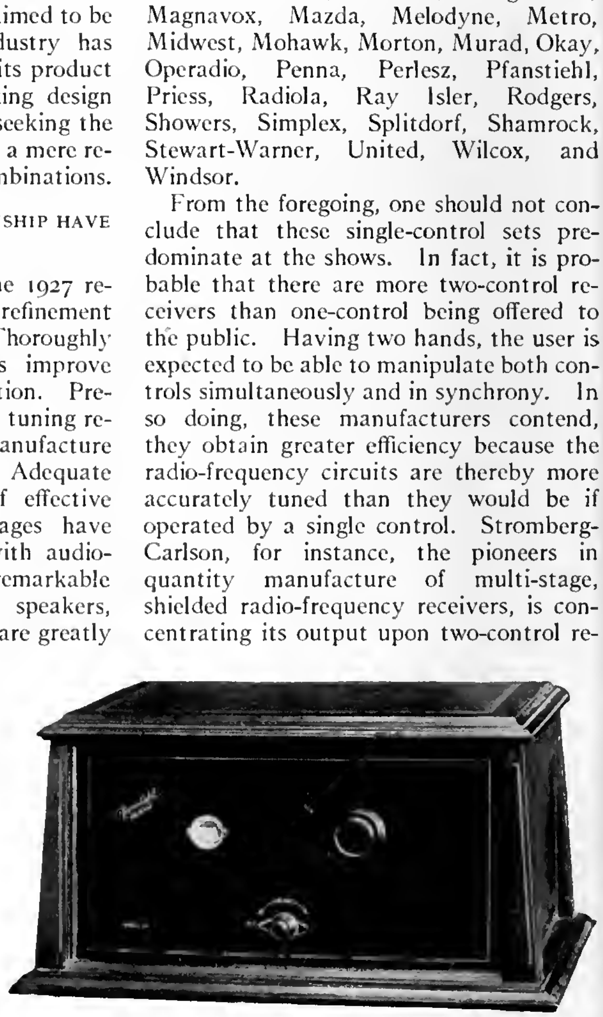
RECEIVER DESIGN AND WORKMANSHIP HAVE IMPROVED

THE technical expert finds the 1927 receiver a real advance in refinement of design and workmanship. Thoroughly shielded radio-frequency stages improve selectivity and stabilize operation. Precisely calibrated radio-frequency tuning represents a degree of precision manufacture entirely new to the industry. Adequate power tubes with a choice of effective coupling methods between stages have provided the 1927 purchaser with audio-frequency amplification of remarkable fidelity and flexibility. Loud speakers, combined in self-contained sets, are greatly improved and contrast pleasingly with the cramped, inadequately small sound projectors of earlier vintages.

So much for generalities as to the year's improvements. We will consider the products of various manufacturers and how they have incorporated these and other improvements. We regret that mention of many meritorious products is necessarily omitted because data was not received in time to be incorporated in this article.

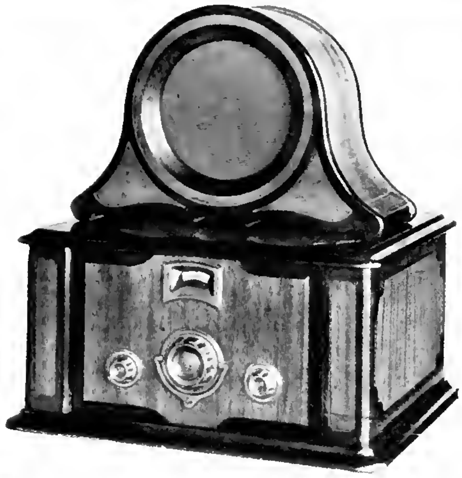
Single tuning-control receivers are considered first only because they represent the most striking, if not the most important tendency of the season. Although the future predominance of the single-control receiver is by no means established, many manufacturers are building at least one model of that kind. A few which have come to our attention are the All-American, Apex, Atwater Kent, Bosch, Cardinola, Chelsea, Crosley, A. C. Dayton, Diva, Distantone, Elkay, Federal, Freed-Eisemann, Ferguson, Franklin, Garod, Hunt, International, Kodel, Kolster, Magnatone, Magnavox, Mazda, Melodyne, Metro, Midwest, Mohawk, Morton, Murad, Okay, Operadio, Penna, Perlesz, Pfanstiehl, Priess, Radiola, Ray Isler, Rodgers, Showers, Simplex, Splitdorf, Shamrock, Stewart-Warner, United, Wilcox, and Windsor.

From the foregoing, one should not conclude that these single-control sets predominate at the shows. In fact, it is probable that there are more two-control receivers than one-control being offered to the public. Having two hands, the user is expected to be able to manipulate both controls simultaneously and in synchrony. In so doing, these manufacturers contend, they obtain greater efficiency because the radio-frequency circuits are thereby more accurately tuned than they would be if operated by a single control. Stromberg-Carlson, for instance, the pioneers in quantity manufacture of multi-stage, shielded radio-frequency receivers, is concentrating its output upon two-control re-



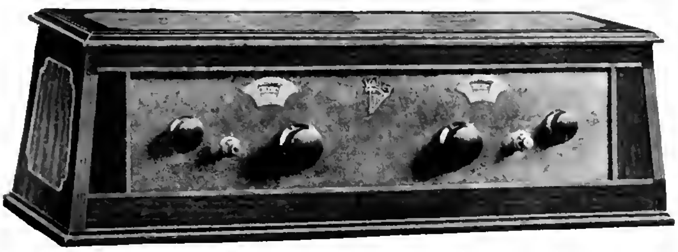
THE PFANSTIEHL MODEL 20

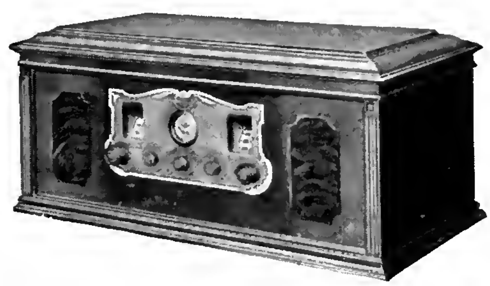
An excellent single-dial receiver, calibrated directly in wavelengths. The dial is illuminated from the rear. Utter simplicity marks this handsome model. Price $125.



FIVE NEW RECEIVERS

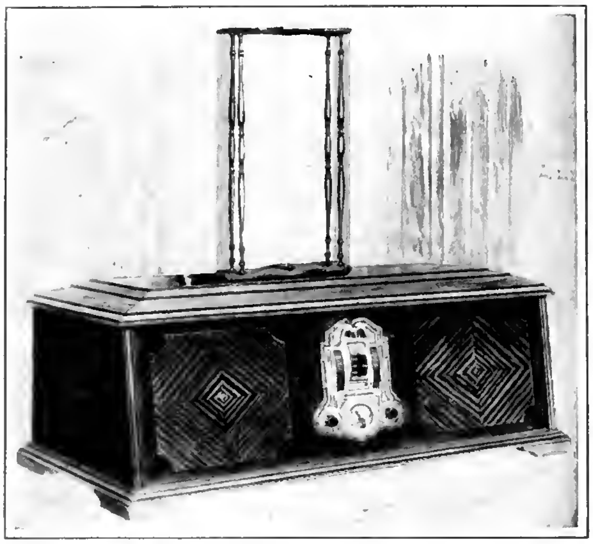
The interesting looking receivet at the upper left is the new Dunn, with three controls easily grasped as one and space for marking in stations; below it the Kodel "Unitrol, with main control tuning all circuits and verniers on either side for more accurate tuning; immediately above is the Magnavox calibrated to wavelengths and with the new Magnavox loud speaker fitting neatly atop the cabinet; a reminder of crystal set days is shown in the Kodel crystal set, upper right, while the fine looking cabinet model at the right is the Workrite neutrodyne with ample cabinet space for all essential accessories

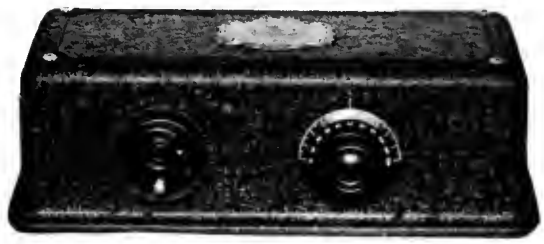


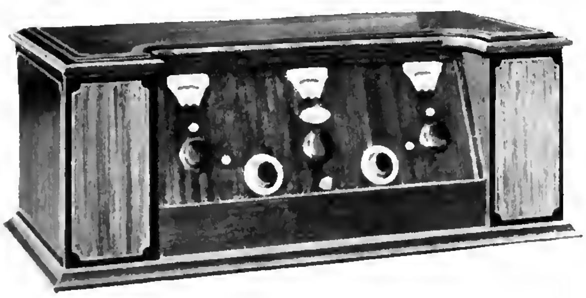


MODELS OF DUAL CONTROL SETS

The long, narrow receiver with the two controls at the center left is the Valley; below it the two-control Gilfillan neutrodyne; at the bottom left is the six-tube Bosworth, with two knurled knob controls which may manipulated by two fingers of one hand. The Fada receiving set above utilizes four stages of radio-frequency amplification, permitting of loop operation, while careful shielding reduces inter-stage effects to a minimum

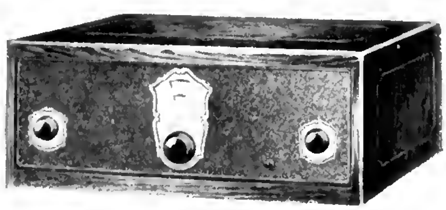


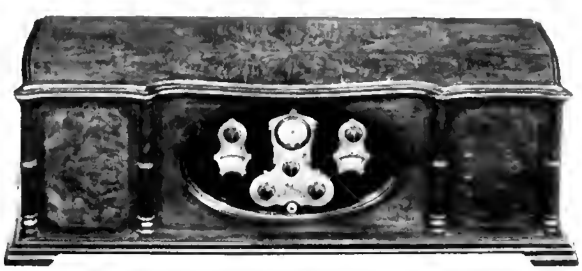




SOME SETS OF THE 1926-1927 SEASON

Four shielded stages of radio frequency amplification make the Freed-Eisemann receiver, at the upper left, sufficiently sensitive for loop pick-up; the Apex, below it, has its tuning control calibrated in wavelengths for the benefit of unskilful operators; the Crosley three-control set is mounted in a handsome cabinet with ample battery compartment space; note the well built Grebe Syncrophase, which may be operated as a single- or three-control set at the will of the operator; below it is the new Atwater Kent single-control with resistance-coupled amplification; the A-C Dayton, just below it, has two controls for rough tuning and two additional for ultra-fine adjustment





COMPACT AND INTERESTING RECEIVERS

Everything fits in the Blair console, including charger, storage battery, eliminator or B batteries and its three closely adjacent knurled controls can be manipulated with one hand; the simple and neat set to its right, above, is the new Stewart-Warner; below is the Argus, with voltmeter to assure operation of tubes to best advantage ceivers. Among others making two control receivers are All-American, Argus, Bosch, Bosworth, Bremer-Tully, Case, Gilfillan, Stewart-Warner, Valley, Workside and the A-C Dayton, the latter employing two additional controls, used only when very precise tuning is attempted.

All single-control receivers are not alike. Among them are represented several degrees of convenience and perfection in design. Some sets have a single master control, combined with extra compensating controls to take care of slight variations in the calibration of the circuits. Other receivers are made with such accuracy and so expertly calibrated under laboratory conditions that no compensating adjustments are needed. Still others are equipped with frictionally coupled or closely spaced controls so that they may be used singly or in unison at the will of the operator. Included in these two groups are models from Bosch, Bosworth, Dunn, Grebe, Radiola, and others.

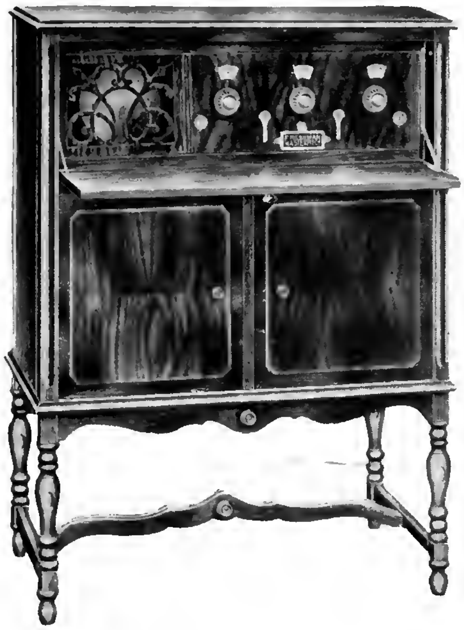
THE GRAND CALIBRATED DIAL

ANOTHER feature which distinguishes these various single-control receivers is the method used in calibrating the indicator. Some are so accurately built that the tuning dial is marked, by the maker, in wavelengths or even by the call letters of the principal stations. Others have drums upon which the user himself indicates the stations, when the receiver is installed in its permanent location. Still others are marked in arbitrary units, such as 1 to 100. Obviously it is a great advantage to the novice to be able to set the receiver to a desired wavelength, according to dial markings. This feature has been incorporated in the products of the Apex, Bosch, Fada, Freed-Eisemann, Kolster, Magnavox, Pfanstiehl, Priess, Shamrock, Stewart Warner, and a number of others.

The receiving set may be divided into

THE PERLESZ SINGLE-CONTROL RECEIVER

An unusual eight-tube new model presented for this season. The attractive cabinet contains a built-in speaker and space for current supply



THE FRESHMAN MASTERPIECE CONSOLE MODEL

Freshman continues his three-control receiver, thus helping to maintain the proportion of three-control to the other types. A built-in speaker is a feature of this moderately priced set

three parts, (1) The radio-frequency amplifier, (2) the detector circuit and (3) the audio-frequency amplifier. The engineers designing 1927 products have given considerable attention to the importance of properly dividing the work among these three departments of the receiver. To accomplish this, many have completely shielded each tube circuit so that it would not affect its neighbor in doing its work. By using several stages of radio-frequency amplification, sufficient energy is delivered to the detector, even with loop pick-up, to operate the detector tube without introducing distortion. Overloading the detector, when listening to near-by, high power stations, or using a long antenna, is avoided by the use of a volume control, reducing the amplification of one radio-frequency tube. The functioning of the detector tube has been aided materially by such design because the tube no longer must deal altogether with signals of greatly varied strength.

The audio-frequency channel also gains by the new balance of functioning introduced by these methods. An audio-frequency amplifier, regardless of type, works with minimum distortion if the tubes are passing normal plate current. If the filament emission is reduced by means of a rheostat, to avoid overloading, the tonal quality is seriously thinned. Likewise, too strong a signal produces the all-too-familiar blasting. The use of a volume control in an early radio-frequency stage, used for several years in the Radiola super-heterodyne, has been adopted by many manufacturers this year.

Another feature which makes for good tonal quality is the operation of vacuum tubes with the correct filament and plate potentials. No matter how skillfully a manufacturer makes his set, its tone output in the hands of the user is not good unless the proper A, B, and C voltages are applied to the vacuum tubes. This problem is aggravated by the fact that many socket power devices deliver different voltages under different load conditions, making it difficult to be certain of the voltage applied. B, and C batteries likewise suffer a gradual fall in voltage as they are used. Distortion sometimes creeps in so gradually that the regular user is not aware of change in quality. Many manufacturers have incorporated voltmeters in their sets or have provided pin jacks so that voltmeters can be installed easily at the option of the purchaser. These meters enable the set user to maintain his tube filaments at the proper voltage.

An interesting feature of the Freed-Eisemann receiver is a switching mechanism by which the plate voltage applied to each tube on the set may be read instantly, as well as that of the A battery at its terminals (giving warning that the battery needs recharging), at the filament terminals (permitting the prolongation of tube life to the maximum by the use of correct voltage) and the various C battery voltages in the audio amplifier.

The Radiola super-heterodyne loop receiver has been long established in the field, but with 1927 come several worthy competitors. By successfully coupling four

THE CROSLEY 5-75

A new model in the Crosley line. Like many of this year's models, the set has a single station selector, with space for writing in stations heard. The set has a built-in reproducer and ample room for batteries. Price $75.

A SEVEN-TUBE RECEIVER
The Rauland "Lorraine" houses a seven-tube receiver and loud speaker in its fine walnut cabinet and offers adequate space for the concealment of all accessories. It retails for $335

stages of radio-frequency amplification with a loop receiver, reception down to the noise level is claimed by several makers of such sets. Precision manufacture in the production of inductances and capacities and the use of effective shielding has made possible the use of four stages of radio-frequency amplification, manipulated by a single or dual control. Freed-Eisemann, Bosch, and Priess have brought forward such models, while Fada has a two-control receiver with such a powerful radio-frequency amplifier. Three stages of radio-frequency with single-control tuning has been brought forward by All-American, A-C Dayton, and Perlesz.

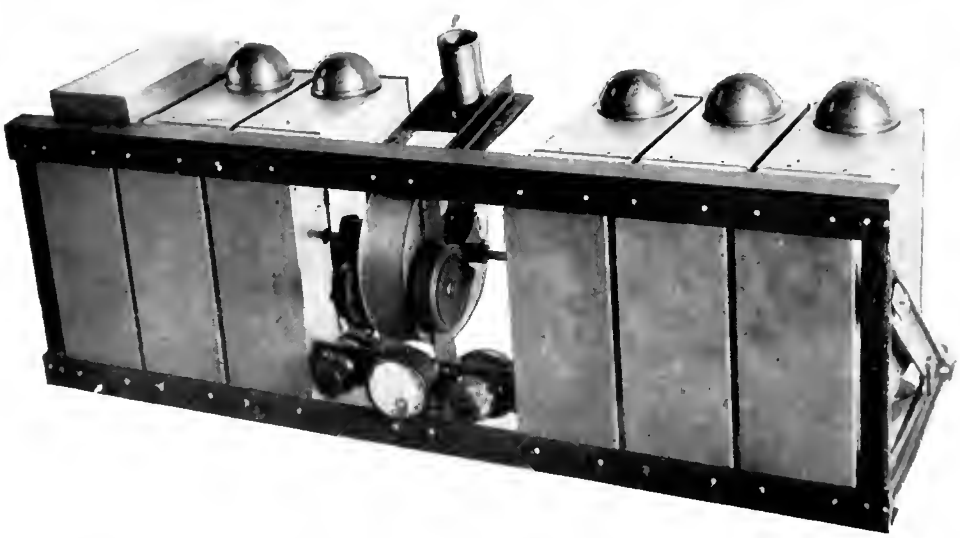
The five-tube receiver which held the dominant place in the field last year finds strong rivalry from the six-, seven-, and eight-tube receiver, but there are still a large number of well established manufacturers, realizing the satisfaction which the five-tube receivers have given, who have stuck to their lasts and continued with five-tube, three-contol sets. They have improved the appearance of their receivers and revised the audio-frequency amplification system to permit of the use of power tubes and a better quality of reproduction. A newcomer in this field is the Sparks-Withington Company, known in the automobile accessory field. Other manufacturers, presenting C models in this field, are the Blair, Freshman, and Splitdorf.

The general appearance of receiving sets has undergone marked changes. The power house, switchboard type of receiver is practically a thing of the past. Neatly illuminated dials have at last replaced the "pie plates" of olden days. A few manufacturers have taken to ornate decoration so that the option of the buyer ranges from an appearance of utmost simplicity and dignity to the last word in new-art, fancy scroll work.

The combination of loud speaker with set is no longer accompanied by sacrifice of quality of reproduction. Earlier attempts in this direction were all too frequently made at the sacrifice of true quality because small loud speaker openings and cramped, thin-necked horns were used in connection with high grade receivers.

Microphonic effects, when extremely large volume is attained with the loud speaker too close to the receiver, have maintained the popularity of the two unit systems, in which the radio receiver and preliminary audio-frequency amplification is incorporated in one unit and the loud speaker and power amplifier in a second. The power unit is arranged so it can be placed sufficiently distant from the first to subdue microphonic effects. The familiar Radiola with the type 104 loud speaker is only one example where this system is employed.

SIMPLICITY AND BEAUTY
Tuning this Ferguson receiver is simply a matter of setting the dial to the wavelength of the desired station. A volume control varies the output to the wishes of its listeners



A COMPLETELY SHIELDED RECEIVER
The chassis of the new Freed-Eisemann "800" neutrodyne. Copper shielding is used for radio-frequency stages and detector tubes. The audio stages are shielded in a steel compartment. The set is loop-operated and uses eight tubes

THE MARRIAGE OF RADIO AND THE PHONOGRAPH

ANOTHER group in the field is the combination phonograph and radio outfit. Since the audio-frequency end of a receiver, comprising preliminary and power amplification and high grade sound reproducing devices, is useful in connection with electric phonographs, it has been a natural development to have this end of the receiver serve a double purpose. We find both Brunswick and Victor in comprehensive lines, involving Radiola receivers and power amplification systems combined with their phonographs. .

While the outstanding feature of the show and the general trend of the industry is indicated by a consideration of the higher priced receivers, the manufacturers have by no means neglected the needs of those who wish to make a modest investment. The improvement in the lower priced merchandise is just as marked as that in the higher field. Many of the lower priced sets have been remarkably improved in appearance and convenience. Even a most cursory examination of the illustrations in this section of the magazine will bring this fact forcibly to the reader's attention.

Parts of Real Quality Dominate the New Season's Lines

A Glance Over the Offerings of Manufacturers Which Are Seen at the Fall Radio Shows—Valuable Improvements for Existing Receivers and a Wealth of Parts for Those Who Are Building New Sets

By RICHARD LORD

AS THE value of mechanical and electrical precision has become better appreciated in every branch of the radio art, parts built with watchmaker's precision have become the rule rather than the exception. The days of touching condenser plates, transformers which might better be called low-frequency filters and rheostats with self-removing resistance windings have practically disappeared. The 1927 offerings of parts manufacturers represent new standards in accuracy and soundness of construction and present the experimenter with opportunity to make the most advanced type of receiving equipment.

Parts may be considered in two general groups:

(1) those which may be used for the improvement of existing receivers, such as trickle chargers, automatic power supply switches, socket power supply devices, audio-frequency and power amplifier systems, loud speaker and console cabinets; and

(2) elements which go into the receiving set itself, such as variable condensers, transformers, dials and a vast array of miscellaneous small parts.

The performance and convenience of existing sets can be greatly improved by the installation of some of these various new devices. The storage A battery, for instance, need no longer engage the constant attention of the broadcast listener and experimenter if he equips it with a device like the Apco Full Automatic Converter. By plugging the proper terminal into the light socket, connecting the storage battery to another pair of terminals and the filament supply leads from the set to a third, the storage battery may thereafter be practically forgotten. The converter automatically places the battery on charge when the set is not in use and it also disconnects the charging device when the charging process is complete. Kodel has brought out a Chargometer which automatically disconnects the charging device when the battery is fully charged. Another convenience is the Brach Controlit which permits of the installation of the storage battery and charger at a point remote from the set. When the set switch is turned on, the charger is disconnected and the B battery circuit automatically switched in. When the set is switched off, the Brach device turns on the trickle charger which maintains the A battery at full charge. The National lead battery people have brought out a trickle A charger and battery unit and also a 2-ampere Tungar outfit.

Willard and Philco present their A battery trickle charge outfits, having a constantly visible hydrometer to show the battery's condition of charge.

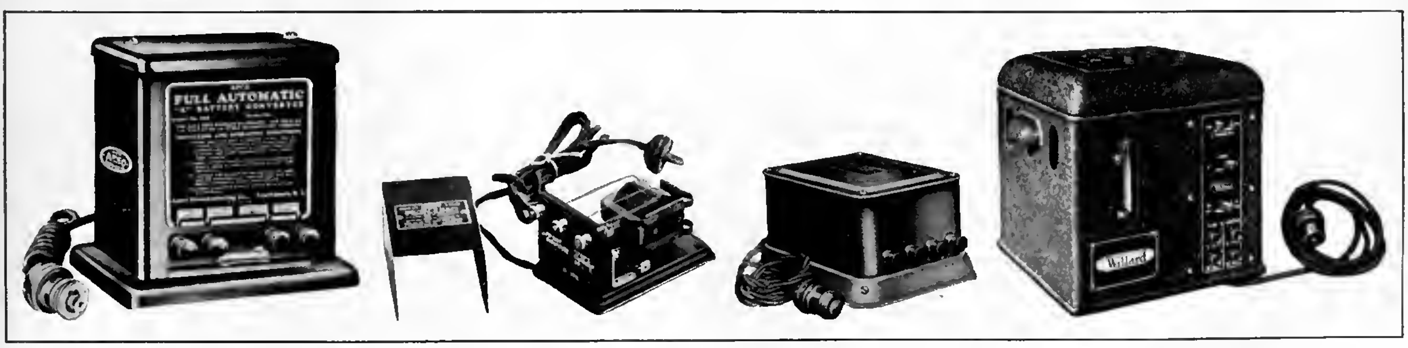
There is a wide range of charging devices which meet every possible condition with which the radio user may be faced. For those having only 110 volt d. c. available, there is the Ward-Leonard Trickle charger. The Unitron electrolytic charger, offering three different charging rates, selected by a switch, is available in styles suitable for 25, 40, and 60 cycle power supply. Other excellent chargers are offered under the trade name of France, Kodel, Liberty, Valley, Westinghouse, and numerous others.

In the field of B battery substitutes are so many meritorious products that it is quite impossible to so much as list them in this brief review of what may be seen at the shows. They vary from outfits like the smaller Apco and All-American devices, with a fixed amplifier output and variable detector voltage, to the Sterling, with its three variable outputs for low, intermediate and high voltage, sufficient to power any standard type of tube, including the UX-210 and supplying also two ranges of C battery voltage, one of 3 to 9 volts and the other of 40 volts. All sorts of intermediate combinations, most of which are equipped with variable detector voltage, one or more fixed or variable amplifier voltages, are available to the user. The manufacturers making several models include such popular names as Acme, Apco, Grigsby-Grunow-Hinds, Kodel, Majestic, Glenn L. Martin, Mayolian, Timmons, and others too numerous to mention.

In the field of the chemical rectifier, B battery substitute devices may be mentioned the Balkite in various models, delivering 90, 135, or 150 volts maximum, according to the need of the user, and some also combined with A battery power supply units. In this field also is the Willard storage B battery, combined with their previously mentioned A battery unit. Another device along these lines is the Philco, which has enjoyed very wide sale.

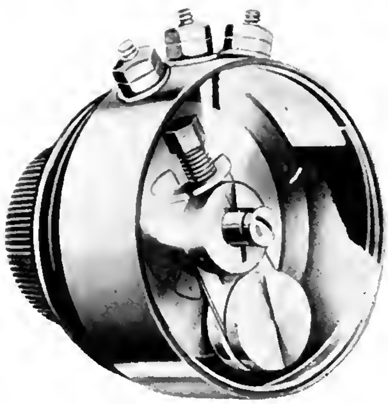
For those desiring to construct their own B battery substitutes, the necessary chokes and transformers, or complete kits ready for assembly, are exhibited by Thordarson, Pacent, Ward Leonard, Silver-Marshall, Apco, Acme, and others.

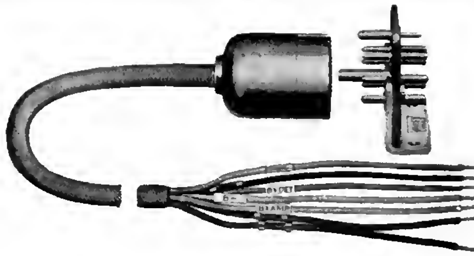
Lest it be concluded from the foregoing that the B battery is a thing of the past, attention is called to the strides made in B battery construction in the past few

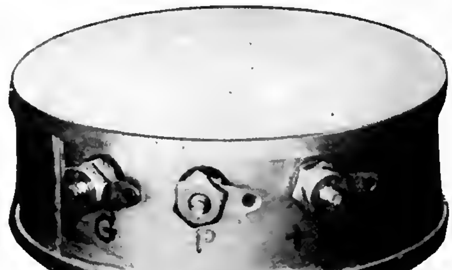


AUTOMATIC DEVICES FOR CONTROLLING THE A BATTERY

Four devices from Apco, Brach, Kodel, and Willard. The Apco arrangement is designed to keep the A battery at maximum charge automatically. The Brach "Controlit" enables the switch of any set to control automatically the operation of B substitute and battery charger. The Kodel "Radio Chargometer" is an automatic switch which disconnects the battery when it is fully charged. Price $10. The Willard Power Unit charges the A battery automatically and also controls B battery charging







FOR THE HOME CONSTRUCTOR

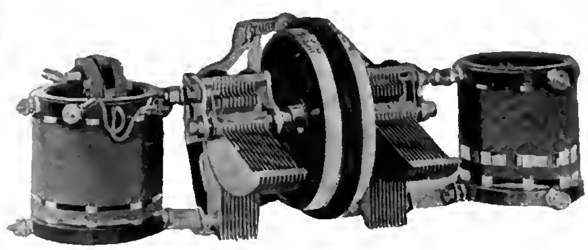
The Marco illuminated dial is shown above; notice the rotary contact, which is a feature of the Frost potentiometer; the Benjamin inductance is self supporting with primary and secondary terminals properly marked

TO REPRODUCE PHONOGRAPH RECORDS ON YOUR RADIO

With the aid of the Bristol device at the left, you can reproduce your phonograph records with the radio set's amplifier and loud speaker

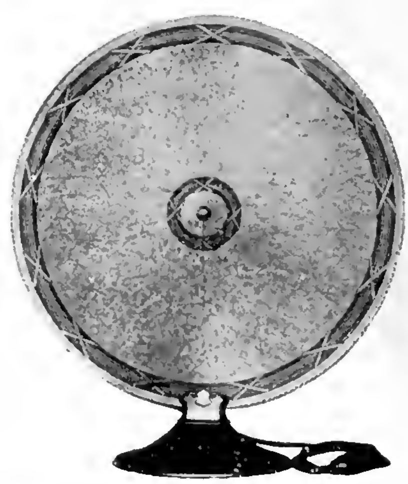
NEW PARTS OF WIDE ADAPTABILITY

At the top is the Yaxley cord and plug which instantly connects and disconnects antenna, ground, and power supply from the set; below it the Sickles shielded radio-frequency inductance just right for the broadcast frequencies; below it the Weston pin-jack meter fitted to a Radiola

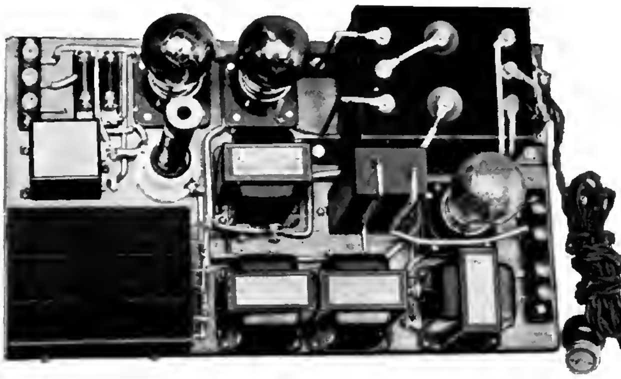


NEW OFFERINGS TO BE SEEN

No microphonic effects trouble the owner of the Detroit Woodwork's loudspeaker cabinet, because it is easily placed at a distance from the set; above is the new Bruno Unitrol, controlling two condensers with two adjacent knurled knobs, according to the latest practice and may be purchased with inductances covering the broadcast band; at the right, we have the giant Pacent 36" auditorium volume cone, capable of handling the output of the largest amplifiers



years. Better construction in much larger units give longer life and ample current capacity for economical sets which require up to 155 volts plate potential. Some of these larger batteries power such receivers for as much as nine months to even a year without renewal. The most novel advance in the B battery field is the National Carbon Company's Layerbilt battery, constructed of flat cell units somewhat on the order of the Voltaic pile. The French Battery Company also has a fine new radio battery, classed as "pitchless," for which very long life is promised.



THORDARSON'S AMPLIFIER AND B POWER SUPPLY

Another concern new to the radio field, is announcing the "Tab" rechargeable B battery for the chemically inclined who may renew the mix in the battery when the first batch is exhausted.

BETTER AUDIO AMPLIFICATION

THOSE desiring better quality of reproduction from their receiving sets, as well as those building new receivers, have at their disposal a choice of amplifier systems by which this objective may be attained. Among those in the resistance amplifier field are the Allen Bradley, Daven, DeJur, and Heath each making three-stage units with or without filament rheostats. Some of these are designed for power tubes in the last stage, having provision for the installation of a C battery.

The resistance amplifier finds rivalling it, various combinations of impedance- and transformer-amplification. The well-known Thordarson line includes the essential parts for a high grade, impedance amplifier, while Rauland-Lyric calls attention to its "trio," consisting of one transformer stage and two impedance stages. And then there is the Na-Ald Trufonic amplifier, a three stage device, built after the design of H. P. Donle. The National Company supplies "Impedaformers" for those desiring to build an impedance amplifier.

In the field of power amplification are various units which may be plugged-in the detector or first amplifier stage of receiving sets, subjecting its output to one stage of power amplification as well as furnishing A and B power for the amplifier tube and also supplying the radio set itself with the necessary plate potential. Thus we have the combination of B battery substitute and power amplifier converting the usual receiving set into one capable of delivering substantial undistorted volume to the loud speaker. These cover a wide price range and furnish B voltage of various ranges, beginning with the neat Radio Receptor device and ranging in price up to models by such experienced makers as Pacent, Farrand, Timmons, and General Radio. The last named, for instance, offers three B battery voltages and one stage of power amplification, using the UX-171 tube.

NEW LOUD SPEAKERS

TO MENTION by name the numerous types of loud speakers available to the public would be almost a hopeless task. They range in size from the little Tower cone at a price within range of the most modest buyer to the Pacent auditorium volume 36-inch cone. Magnavox has announced a new and neat model, while Acme, already well known in this field, has produced a new type cone with a base so shaped that the cone may be placed within a cabinet. A newcomer in the field is the Sparton, automobile horn maker, with several types of free-edge cones, while the Utah line combines a variety of unique shapes and styles for those preferring something not along the conventional lines. Owners of receiving sets, having high grade power amplifiers, may, by using a Bristol electric tone-arm, play phonograph records and use their radio amplifying system to reproduce them. This device performs a function just the reverse of a phonograph adaptor.

Another method of improving a set is to eliminate unsightly accessories. Console cabinets, combined with loud speakers and having an ample battery compartment are exhibited in numerous styles by such makers as Pooley, Detroit Woodcraft, and others.

An economy measure and an essential in checking the condition of A and B batteries are various meters manufactured by Weston, Roller Smith, Hoyt, and Jewell. The first concern is exhibiting a dual range voltmeter with pin jacks, provision for the installation of which is made on such well known manufactured sets as the Radiola super-heterodyne and some of the receivers in the Bosch line.

The set constructor who has examined some of the latest manufactured receiving sets is likely to feel that he can no longer hope to make a radio receiver which approaches the precision and quality of some of the more expensive manufactured sets. Of course, this cannot be literally true, because every manufactured set had its hand-made predecessor which served as a model. Some parts manufacturers have gone a long way to help the constructor in making a receiver at least comparable to some of the better manufactured sets.

SPECIAL NEW PARTS FOR THE SET BUILDER

THE Alden localized control gang condensers, for example, offer the convenience of one control for two, three or four tuned circuits. The condenser shafts are mounted parallel instead of at right angles to the panel and are separately controlled by closely adjacent, knurled knobs, all of which may be moved simultaneously with the aid of two fingers of one hand, or separately at the will of the user. The Bruno device, built along the same lines, controls two condensers and may be purchased with inductances attached, covering the broadcast band. The Bruno

NEW UNITS FOR SUPPLYING B POWER

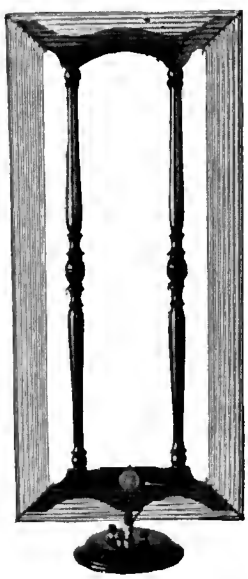
The Valley B Power, using Raytheon tube; the Balkite Combination Radio Power Unit, which, when connected to the A battery furnishes power both to A and B circuits. It is controlled by the filament switch on the set and is automatic. Price $59.50. Next is the General Radio Power Amplifier and B supply. Finally, the All-American "Constant B" using a Raytheon tube, which sells for $37.50

NEW ACCESSORIES FOR THE SET OWNER

At the left is the new Sparton cone loud speaker; below it the Samson output transformer, which prevents the B potential from flowing through the loud speaker windings; underneath it is a cutaway illustration of the Eveready Layerbilt B battery, which gives great capacity in a small space, inter-cell waste being eliminated; at the bottom left is the Hammarlund variable condenser which combines the advantages of straight frequency line at the high frequencies and straight capacity line at the low end

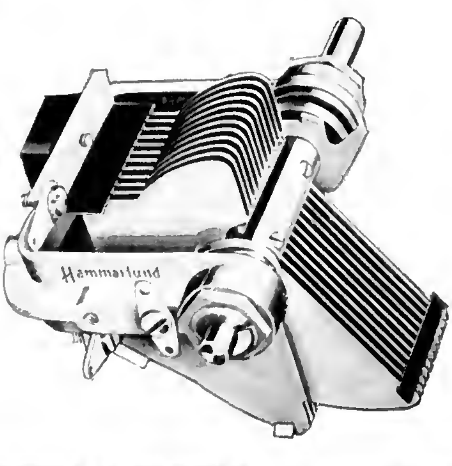
TWO NEW RADIO DEVICES

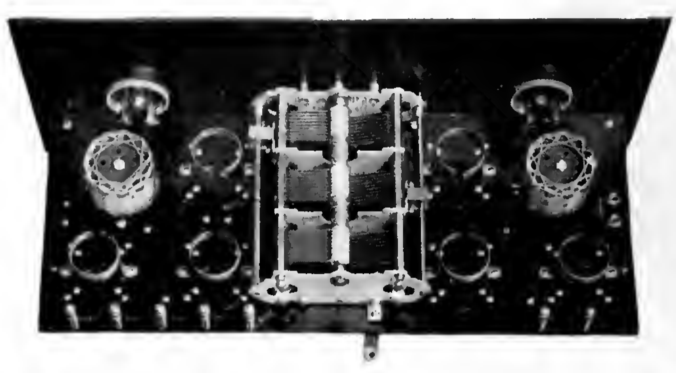
The Air-Gap socket eliminates socket losses between grid and plate terminals by its cutaway construction: the National Radio A power unit combines a trickle charger with an A battery; while below is the Bodine loop



A BATTERY CHARGER AND ASSEMBLED KIT

At the right is the Valley charger, equipped with a meter to show the charging rate; below is a Pierce-Airo kit assembled. The set is tuned by a triple gang condenser





control is designed so as to engage the neighboring knurled knob after the other has been turned single for more than 10°. It is equipped with a bakelite shaft, reducing losses occasioned by long metallic shafts.

The conventional gang condensers, controlled from a single shaft, maintain their sway, following the design of previous years.

There are a number of innovations in the variable condenser field. Considering the innocent appearance of the variable condenser, it has been subjected to rather sensational publicity in the past two or three years, first by the discovery of the phrase "low loss" and then by the straight-line frequency hysteria. This year, in which there have been some very real advances in condenser design, there is not, however, the fanfare of excessive publicity.

THE ELECTRAD LINE OF PARTS

Electrad makes a comprehensive line of small parts which contribute so much to the efficiency of the home built receiver

THE WARD LEONARD D. C. CHARGER

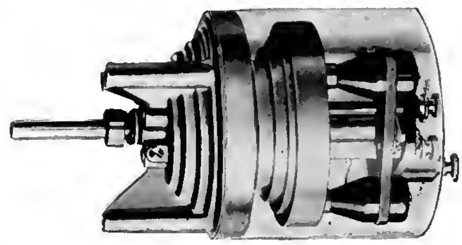
One trend is indicated by the new Hammarlund, the General Instrument Metralign, and Silver-Marshall variable condensers. It has been discovered that just as the straight capacity line condenser crowded the short wavelength stations too closely so the straight frequency line condensers spread the long stations too far apart. These manufacturers have announced a compromise between these two types so that stations are aligned along the dials in such a way that the relative congestion of different parts of the broadcast band is taken into account. Another departure in condenser construction is the Furnell which substitutes for flat, interleaving plates, a conical type with a worm drive for adjustment, covering a range of 360° from minimum to maximum.

ADVANCES IN SHIELDING

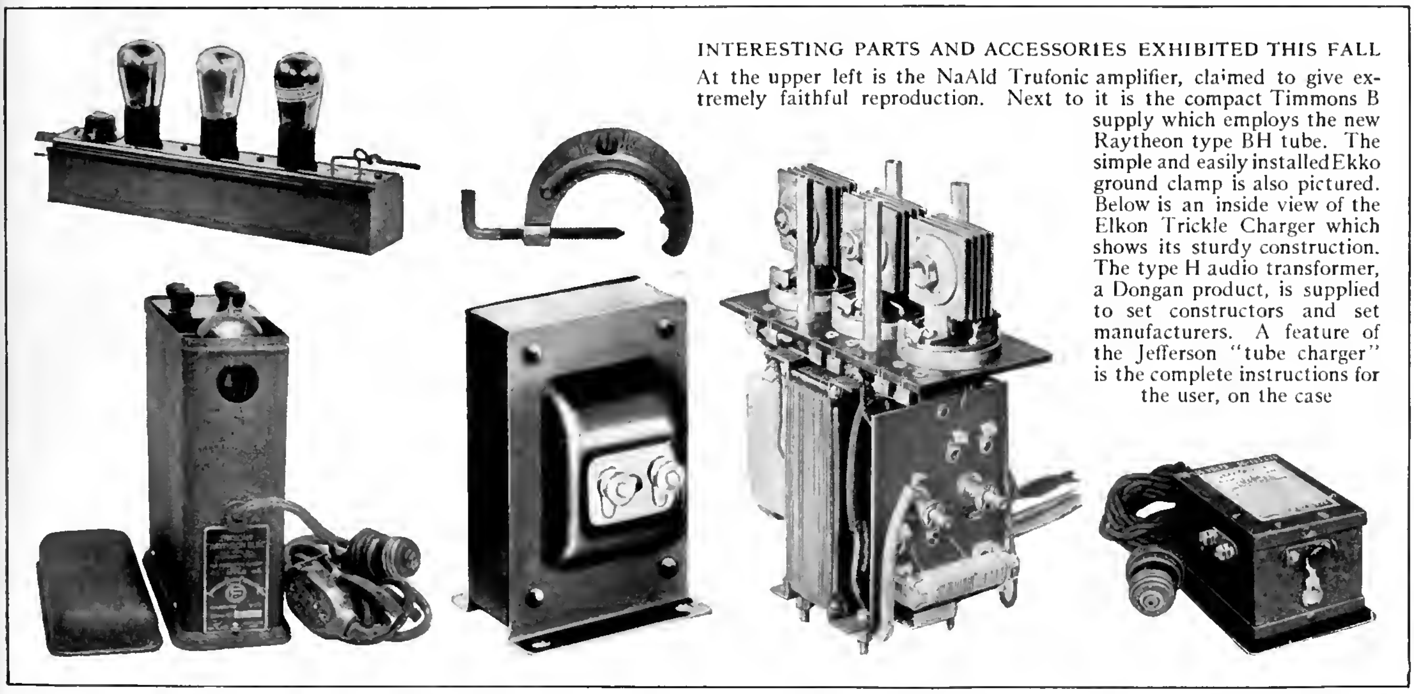
THE tendency toward shielding is recognized in the General Instrument shielded radio-frequency unit, offering coil, condenser and socket in a completely shielded can. Silver-Marshall offers a similar outfit in kit form, while Sickles has produced a radio-frequency transformer coil completely shielded in a can only $1\frac{1}{8}''$ thick and $3''$ in diameter, the enclosed inductance covering the broadcast band with a condenser of 0.00035-mfd. capacity.

Although the subject of audio-frequency transformers has already been partly covered in the section on audio-frequency systems, several manufacturers have already announced new transformers, involving improvement over their predecessors. The Samson model, for instance, is completely enclosed in a metal shield, reducing stray effects. The Ferranti, imported from London, shows a most promising calibration curve, for which the user pays a rather handsome price.

In the field of small parts, such as sockets dials, switches, resistances and rheostats, are many ingenious improvements. By utilizing the Marco illuminated dial, the ambitious home constructor, with the aid of its rigid metal template, may equip his homemade receiver with a very fine, illuminated dial. In the comprehensive Carter line of jacks, switches, rheostats, and dials are such interesting products as the Dialite, which not only illuminates the panel but indicates whether the A battery is on or off, and jack switches permitting of substantial circuit changes



THE INTERESTING FURNELL CONDENSER



INTERESTING PARTS AND ACCESSORIES EXHIBITED THIS FALL

At the upper left is the NaAld Trufonic amplifier, claimed to give extremely faithful reproduction. Next to it is the compact Timmons B supply which employs the new Raytheon type BH tube. The simple and easily installed Ekko ground clamp is also pictured. Below is an inside view of the Elkon Trickle Charger which shows its sturdy construction. The type H audio transformer, a Dongan product, is supplied to set constructors and set manufacturers. A feature of the Jefferson "tube charger" is the complete instructions for the user, on the case through the adjustment of a small, inconspicuous, single hole, mounted switch. Centralab, in its extensive line, features the Modu-plug, which combines a high resistance volume control with the conventional loud speaker plug. Alden has a line of sockets and adaptors fitting every conceivable combination of requirements so that any set may be adapted to the use of any standard tube. A new socket, known as the "Air Gap" separates by an air space the grid and plate terminals, reducing such losses as might occur there to an absolute minimum. Sofruba, as its name indicates, attempts to meet the problem of microphonic tubes by a socket made of spongy material. Eby has succeeded in applying ingenuity to the socket problem by designing a new kind of terminal, making the soldering of bus bar or wire simple, effective and quick. Clarostat seems to have the record in variable resistances, its unit covering from 0 to 5,000,000 ohms, while their Clarotuner is a fixed tickler with regeneration controlled by a similar unit. Arthur Lynch presents a fixed resistor mounted in a glass tube, claimed to be absolutely impervious to moisture and weather conditions, in sizes to meet every radio need for fixed resistances. Electrad presents a line of variable resistances of low and high resistance, fixed units in glass tubes and numerous other well made small parts of wide service to the home set builder.

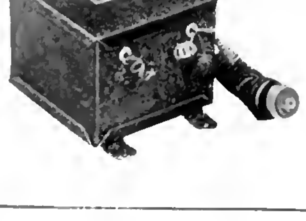
A POWER AMPLIFIER AND B CURRENT SUPPLY

This Timmons product combines one stage of power amplification with a B battery eliminator

Finally, in the vacuum tube, we find the new, highly sensitive Radiotron 200-A detector tube, which should appeal to the DX fan. A similar tube is made by Donle-Bristol. Raytheon has improved its rectifier tube so widely used in B battery substitutes by increasing its output capacity to 85 mils, its rating to 200 volts and its voltage regulation so that there is practically no fluctuation through current drains ranging from 10 to 85 milliamperes. Apco harks back to pre-war days in tube construction by offering a tube with two filaments, thus doubling its useful life. Daven makes specially high-mu tubes for resistance amplifiers. Ceco features a detector tube of special characteristics, while Supertron calls attention to its isolantite member which assures absolute rigidity of plate, grid and filament in its vacuum tube. Perryman, Ken Rad, and Cleartron show tubes both small and large with conventional characteristics.

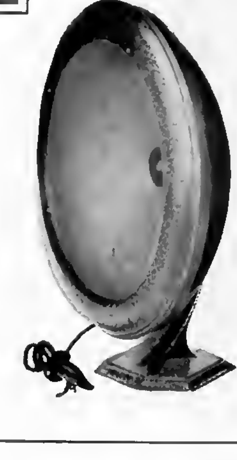
This rather abbreviated sketch of what may be seen at the shows calls attention to only a few of the interesting high lights, but it serves to indicate the year's progress.

For those who do not wish to go to the trouble of selecting parts for their receivers, there is a variety of kits which may be successfully assembled by fairly inexperienced constructors The Pierce-Airo, for instance, is a receiver having two stages of tuned radio-frequency, detector and three stages of resistance amplification, controlled by a single dial with two verniers. Bruno presents a receiver of one stage of tuned radio-frequency with a regenerative detector and three stages of resistance-coupled amplification. Silver-Marshall offer a similar outfit, as well as their "Shielded Six," consisting of three stages of radio frequency, detector and audio-frequency amplifier with each stage mounted in an enclosed can, preventing inter-coupling effects. A six tube tuned radio frequency receiver with a three-stage resistance amplifier is being shown by the Heath Radio and Electric Company.



NEW OFFERINGS FOR THE RADIO PURCHASER

Two reproducers are shown, on the left, the Rauland "Lorel" cone type speaker and on the extreme right, the Acme cone which has a base of such form that it is easily mounted within a set cabinet. Two B supply power units are shown, the Majestic, and the J. Andrew White. The Majestic is from Grigsby-Grunow-Hinds and has two variable voltage outputs as well as a high and low amplifier output control, suiting it for use with any standard tube. The Andrew White unit has several output taps with 135 volts as its maximum



How to Select Your 1927 Receiver

Five Main Requirements Which a Receiver Must Satisfy—Direct Help for the Prospective Purchaser, Confused by a Maze of Claims—How to Judge the Necessary Accessories

By EDGAR H. FELIX

A TINY urchin, appraising the stock of a confectionery store, with two pennies clenched in his hand, is naturally hesitant. His bewildered mind attempts to make the wisest expenditure of his hard earned accumulation of capital, but, with so many good things to choose from, his indecision is distressing to behold.

No less confused is the mind of the novitiate radio buyer, after a tour of inspection at one of the great radio shows. Hundreds of attractive models have lured his eye; claims and counterclaims have raised havoc with his preconceived opinions and his lack of technical knowledge has taken from him the courage to make a confident selection.

By adopting a systematic plan of selecting a receiver, it is possible for the most uninformed person to find the product which is best suited to his needs and his pocketbook. If you know definitely what qualities you wish your receiver to possess and know how to determine whether it possesses them, selection is not difficult.

We have reduced the fundamental qualities of the radio receiver to five and they are listed in the order of their importance from the standpoint of the entertainment value of the receiver. These five cardinal qualities are:

1. Fidelity of tonal reproduction at the maximum volume you desire;
2. Adequate selectivity to meet your receiving conditions;
3. Simplicity of control and maintenance, to make operation a pleasure for every member of the family;
4. Sensitiveness sufficient to bring in the stations you wish to hear; and
5. Appearance, to fit the receiver to its surroundings in the home.

Fidelity of reproduction is, without doubt, the most important essential quality of a receiving set intended for entertainment purposes. The outstanding developments of the past year in this direction have been the improved transformers, resistance- and impedance-coupling devices and power tubes which make possible truthful reproduction at any volume which a user may desire.

The volume which a receiver can handle without overloading is limited by the capacity of the last vacuum tube used. You must decide between small tubes, such as the UX-201-A and the UX-199 types; semi-power tubes of the UX-171, UX-120, and UX-112 type; and large power tubes, such as the powerful UX-210.

The small tubes, of the UX-201-A and UX-199 type, are capable of handling only relatively small output. With a good loud speaker and a powerful signal, small tubes can fill a moderately sized room with music of good quality, provided outside noises, such as heavy motor traffic or many people moving about, do not interfere. But, should you desire to flood a good sized living room with radio music so that five or six may enjoy it without being compelled to refrain from conversation, the semi-power tubes are recommended. Most receivers are equipped so that you have your choice between small or semi-power tubes in the last stage. Even those who must depend upon dry cells for filament current have semi-power tubes at their disposal.

The semi-power tubes do not really give greater volume than the small tubes, but they have the important ability of giving clear, undistorted music with very satisfactory volume. The small tubes, on the other hand, are likely to give scratchy and raucous reproduction if pressed to give their maximum output.

The large power tubes, such as the UX-210 require 110-volt alternating power supply to furnish the necessary high plate potential and filament current which they use. Do not consider a large power tube unless you have electric lights in your home. Large power tubes deliver sufficient volume to furnish dance music for a dozen couples in a large living room.

THE FIRST STEP IN SELECTION

MAKE your first step in selection the decision whether you require only a small tube, a semi-power tube or a large power tube in the last stage of amplification of your receiver. This decision rests on conditions which may differ in every home—whether rooms are large or small, the number of members of the family and the existence of disturbing outside noises.

The tonal quality of a receiver is the product of the audio-frequency amplifier, the plate voltage supplying it, and the loud speaker. Each of these units must be designed to work together properly to give you good results. Your ear tells you if they perform to your satisfaction. You need no technical knowledge for that. But assure yourself, when a receiving set is demonstrated to you, that it is equipped with the same loud speaker and the same power supply—whether B batteries or B substitute—that you intend to install at home. A test with a different brand of loud speaker or different power source certainly does not tell you positively how the device will work with other accessories in use.

The loud speaker which converts the electric output of the receiving set into sound waves requires as much care in selection as the receiving set itself. In a general way, cone types rightly are greatly increasing in popularity and there are many high grade cones available to the set buyer. Some are low pitched; others are high pitched. If music sounds too low and throaty, ask for a higher pitched cone. When cone or horn is a part of the receiving set, a ringing effect is sometimes heard, arising from the vibration of the tube elements. When such a receiver is demonstrated, listen critically for this undesirable effect, particularly with loud music, lest you purchase a receiver in which it has not been completely overcome.

To test the quality of reproduction of a radio set, ask the salesman to tune-in a near-by, high power station, with the exact equipment which you intend to install in your home. Listen carefully with moderate volume to the music. Then slowly and gradually have the volume increased, listening for any change in the fidelity of the music. When it begins to sound rough and scratchy, you have reached the volume limit of faithful reproduction. Be sure that the volume before this point is reached is adequate for the purpose for which you desire to use your radio set.

Listen carefully for low tones. A receiver which fails to reproduce low tones accentuates the melody part of an orchestra's playing in the upper registers and fails to give adequate emphasis to the rich, booming, low tones upon which lies the burden of carrying the rhythm. An organ program is a particularly effective test for the efficiency of a receiver in reproducing low notes. A good receiver makes the organ sound majestic and powerful; a receiver producing only the high frequencies efficiently gives a thin and flute-like reproduction of the organ. The soprano voice and the piano demonstrate the reproduction of high tones, the voice sounds thin and nasal and the piano tinny and twangy, if the upper registers are not well reproduced. Remember that fidelity of reproduction is the paramount criterion to receiver selection and that, consequently, it merits most careful demonstration.

Selectivity is of great importance in congested districts such as New

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FIVE MAIN QUALITIES OF A RECEIVER

WHEN the various qualities of a radio receiver are really reduced to their lowest terms, the points one looks for are not many. With the requirements so simplified, picking out an outfit to meet one's individual needs is not difficult. The points:

1. *Fidelity of tonal reproduction at the maximum volume you desire*
2. *Adequate selectivity to meet your receiving conditions*
3. *Simplicity of control and maintenance, to make operation a pleasure for every member of the family*
4. *Sensitiveness sufficient to bring in the stations you wish to hear*
5. *Appearance, to fit the receiver to its surroundings in the home.*

This article gives, in as much detail as possible, information on how to apply tests on all five points before you buy. It is probable that most purchasers, even those who "know nothing about radio," unconsciously consider most of these points, with the exception of points 1 and 2. The new receivers on the market this year, in the main, are especially satisfactory on these two counts.

York, Chicago, and Los Angeles and other cities where numerous broadcasting stations operate on closely adjacent wavelengths. A local high power station sets up such great energy in the antenna system, that it is heard over a somewhat wider span on the tuning dials than are the signals from distant stations of equal power. Overlapping of stations occurs in crowded areas unless the receiver is selective.

TESTING A SET FOR SELECTIVITY

IT IS not difficult to test a receiverf or selectivity. Have the receiver tuned to the nearest, local, high power station. With the program coming in at full volume, have the tuning dials turned one degree off the maximum point at which the station comes in. Note carefully if there is any drop in signal strength as a result of this manipulation. If a one-degree swing of the dial in each direction from the maximum point weakens the signal, you may be quite sure that the receiver is highly selective. If a two-degree swing causes the volume to fall off markedly, it is satisfactory for use in congested districts. On the other hand, if a three-degree swing of the dials in each direction does not weaken the signal considerably, the set is not adequately selective to cope with congested conditions.

No one circuit can rightfully claim the monopoly of selectivity. There are many circuits which, if utilized in well designed receivers, are adequately selective. On the other hand, the most efficient circuit may be so unscientifically applied in the receiver design that it is not selective. So look to the demonstration of performance rather than to any wordy argument about circuit superiority for the proof that a receiver is selective.

Simplicity divides itself into two classes: simplicity in tuning and adjustment, and simplicity in maintenance. The greatest convenience in tuning is found in those receivers which have a single, calibrated dial, marked in wavelengths or frequencies, so that you can set the dial to the station which you desire to hear, provided you know its wavelength or frequency. The only other essential control devices are a means of controlling the volume and a switch to turn the set on and off.

At the other extreme is the receiver which has three or more tuning controls, several filament rheostats, separate switches for power supply devices and directional loops which must be turned toward the desired station.

Receivers of years ago had almost more controls than are found in a railway signal tower. The tendency in the last year toward simplification has been marked. Now there are many models with but one tuning control. Other manufacturers support the two control set, claiming greater selectivity. When more than two controls must be manipulated to tune in a station, it becomes difficult for one pair of hands to do the work. But the three-control set has advantages too, because its less expensive design and manufacture permit of a lower selling price.

MAINTENANCE—ANOTHER IMPORTANT POINT

CONVENIENCE in maintenance is determined by the means used to obtain filament and plate current. Where power lines are not available, dry-cell tubes are usually used because a storage battery is an unhandy article to take out and have charged every two or three weeks. So long as the receiver has only five or six dry-cell tubes, it is not necessary to renew the dry cells so often that it becomes annoying. Where power is at hand, storage battery tubes are usually preferred because they give greater amplification and better signal volume.

If you select the storage battery type, consider a storage battery charger an essential part of the receiving set. Include it in the first cost because it is necessary to reliable reception. A storage battery receiver, without means of charging, is as helpless as a motorist in a desert. Both need outside help, if the fuel supply becomes exhausted.

To those who must rely on dry-cell A batteries, the number of tubes in the receiver is quite important. The use of more than five or six dry-cell tubes results in such heavy current drain that the dry-cells must be quite frequently renewed.

Plate potential may be secured from the power line or from B batteries. Much attention has been given in the public press to the development of devices for securing plate potential from the power line. Many of these devices are practical and convenient; others operate with a certain amount of hum and require frequent tube renewal. On the other hand, it must be said, in all fairness, that B batteries have also been greatly improved in the last few years, with respect to economy and length of life. If large batteries, made by reputable manufacturers are used, they power most five- or six-tube receivers for six to nine and sometimes even twelve months without replacement. High grade B battery substitutes have proved very satisfactory but some inferior, low priced, poorly constructed devices cause so much hum that they are far inferior to B batteries.

If you plan to purchase a B battery substitute, be sure, when having the receiver tested for fidelity of reproduction, that the device which you plan to buy is demonstrated with your receiver. If the hum is disagreeable, try a different make which gives less hum or install B batteries.

THE SENSITIVITY TEST

THE fourth quality to which you must give attention, when selecting a receiver, is its sensitiveness. If the radio receiver is purchased for musical entertainment and not for chasing long distance ether rainbows, sensitiveness is a minor factor. There is a thrill in long distance reception akin to that of speeding in an automobile. But the receiver which is stressed as the king of distance getters does not always possess the more important factors of tonal quality and simplicity already discussed. As the true musical value of radio reception has become apparent and the grade of programs available through near-by stations has substantially improved, the inferior tonal quality of reception from long distance has made distant programs of decreasing interest. Still there are a few who would rather hear a sneeze from Honolulu than a symphony concert from a local station. To these few, the radio frequency end of the receiver is of utmost importance. The greater the number of efficient stages of radio-frequency amplification, the more sensitive the receiver.

The average receiving set owner needs sensitiveness only sufficient to receive stations within 150 to 250 miles with adequate volume and high quality. A daylight range of 100 miles indicates a receiver sensitive enough to bring in all the stations within range of good quality reception. For instance, if a dealer can demonstrate the reception of Philadelphia stations in New York City by daylight, with good quality, he has proved a degree of sensitiveness which will meet the demand of practically every listener.

Little need be said on the subject of appearance because your own eye is a quick and sound judge, although your pocketbook is often the only limitation in your choice. In judging appearance, the receiver should be considered completely installed, with all batteries, power supply equipment, charging device, auxiliary amplifiers and loud speaker connected. A neat looking cabinet does not always mean a neat installation because provision is not always made for inconspicuous placement of associated equipment. On the other hand, some receivers have a place for everything so that every accessory is neatly concealed.

HOW TO LOOK FOR THE FIVE POINTS IN JUDGING A SET

BRIEFLY stated, the five points indicated in this article to enable the prospective purchaser to judge a receiver he is considering can be presented thus:

1. Quality of Reproduction
   (a) *Small, semi-power, or power tubes in last audio stage.*
   (b) *Reproduction with loud speaker and power supply of type to be used with the receiver.*
   (c) *Demonstration for reproduction of low and high tones.*
2. Selectivity
   Test by observing over how many degrees of the dial near-by stations are heard.
3. Simplicity
   (a) *Number of controls used in tuning.*
   (b) *Ease with which filament and plate potential is maintained.*
4. Sensitiveness
   Ability to receive over moderate range by daylight with good quality.
5. Appearance
   Fitness of receiver, with all accessories connected, to be installed in your home.

Meet Mr. Average Radio Enthusiast

The Extremely Interesting Results of a Comprehensive Survey Made of "Radio Broadcast" Readers—Who They Are and What They Want in Radio—The Future of the Parts Business

By KINGSLEY WELLES

Drawings by Franklyn F. Stratford

COMPOSITE photographs, made by stacking a number of negatives and printing them together as one picture, are sometimes used to show the average type of a group. Several years ago, such a composite photograph of the five leading candidates of one political party was compared by an astute publicity man with a similar photograph of five of the opposition, to prove what a lot of ruthless, hard-boiled, political crooks were opposing the mild mannered reformers of his party.

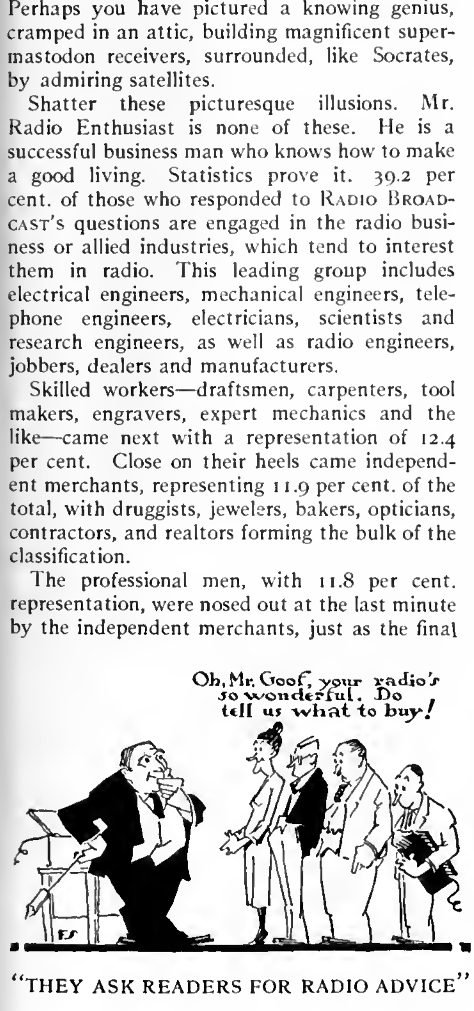
Radio Broadcast has just completed a composite photograph of the average radio enthusiast. There is room in every home for this picture, over the radio set. More than two thousand readers were asked to coöperate in making the picture; more than seven hundred responded. There is every reason to believe our picture is really true to type.

Perhaps you have formed your own conception of Mr. Radio Enthusiast. You may have imagined him to be a learned type, poring over a calculus through heavy, bow rimmed glasses, or a long-legged youth in short trousers, drilling holes in a panel clamped to the library table. Perhaps you have pictured a knowing genius, cramped in an attic, building magnificent super-mastodon receivers, surrounded, like Socrates, by admiring satellites.

Shatter these picturesque illusions. Mr. Radio Enthusiast is none of these. He is a successful business man who knows how to make a good living. Statistics prove it. 39.2 per cent. of those who responded to Radio Broadcast's questions are engaged in the radio business or allied industries, which tend to interest them in radio. This leading group includes electrical engineers, mechanical engineers, telephone engineers, electricians, scientists and research engineers, as well as radio engineers, jobbers, dealers and manufacturers.

Skilled workers—draftsmen, carpenters, tool makers, engravers, expert mechanics and the like—came next with a representation of 12.4 per cent. Close on their heels came independent merchants, representing 11.9 per cent. of the total, with druggists, jewelers, bakers, opticians, contractors, and realtors forming the bulk of the classification.

The professional men, with 11.8 per cent. representation, were nosed out at the last minute by the independent merchants, just as the final returns came in. Dentists, surgeons, librarians, lawyers, writers, ministers, architects, and a score of other learned professions were represented in this group.



"THEY ASK READERS FOR RADIO ADVICE"

If you think there is anything lowly in caste about Mr. Average Enthusiast, revise your opinion. Executives—the patricians of industry and commerce—bankers, manufacturers, railroad officials, exporters and importers—men who own their motor cars and have actually paid for them—formed a group comprising 11.5 per cent of the total answering the questionnaire! Now you know who buys the $9.00 transformers.

Office workers (such as clerks, accountants, salesmen, agents, customs inspectors, and what-not) wearing clean white collars, in spite of addiction to radio as a hobby, came through with 10.2 per cent. of the vote.

The remaining 7.8 per cent. were divided among students (5 per cent.), sailors, army and navy officers, coal heavers (a total of one), housewives and miscellaneous other defenders of the home.

Friend reader, when you are chided that your addiction to radio is disgraceful, that it is the hobby of small boys and lunatics, quote these figures. Arise in righteous wrath and defend the dignity of the followers of radio!

HOW LONG HAVE YOU BEEN INTERESTED IN RADIO?

BUT this is not the only revelation deduced from these questionnaires. How long does radio hold its following? I venture to recall the early days when my case of radio infection first became really serious. Twelve years ago, I sat with headphones clamped to my ears. Behind me there was a whispered family conference. I overheard. "He'll get over it soon," said a voice. "Yes, that's our only hope," said another. "Time will restore his sanity," followed a third. No cure was found. And no cure has been found for the virus radio.

The questionnaires yielded the surprising fact that 89.8 per cent. of Radio Broadcast's readers have been interested in radio for more than three years; 30 per cent. for more than six years and 26.1 per cent. for more than ten years. So, if you are one of the newly infected recruits, do not think that time will effect a serious moderation in your enthusiasm; rather realize that you will be gripped more and more firmly. We assume, of course, that you are like Mr. Average Radio Enthusiast.

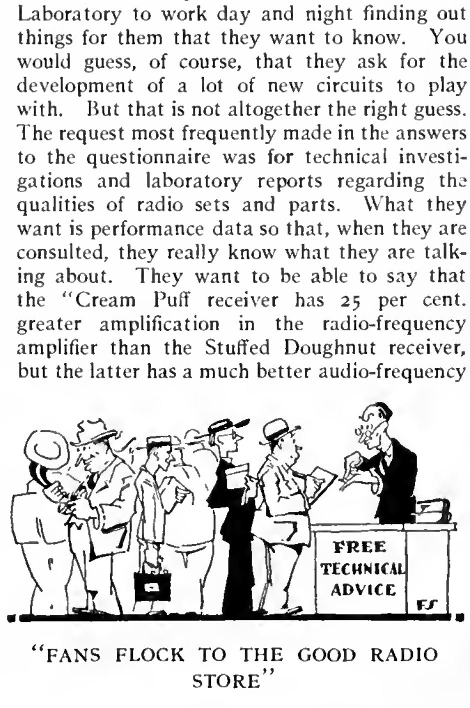
You swell with pride when friends consult you about the purchase of radio sets. It is flattering to be recognized as a radio authority in the community. But is not the experience and knowledge you have gained by building sets and by long study of authoritative publications ample justification for the deference with which you are consulted?

THE READER ADVISES WHAT TO BUY IN RADIO

IF YOUR wife is proud of you because the iceman, the baker, the butcher, the boys at the club and all the in-laws consult you before buying their radio sets, do not let her see this copy of Radio Broadcast. Of course, she always struggles to get hold of it, even before you have had a chance to read it. But she must not be permitted to learn that no less than 79.2 per cent. of Radio Broadcast's readers have been consulted as experts in the selection of sets. A scattering of experts in the radio art have been consulted by as many as a hundred and more friends, seeking the benefit of their thorough radio knowledge. By totalling up the number of sets which each has advised upon, we find that these 575 oracles were consulted in the purchase of 10,827 sets. Since 727 is only $8\frac{1}{3}$ per cent. of Radio Broadcast's total circulation, we come to the conclusion that over 125,000 radio sets have been purchased on Radio Broadcast readers' recommendations.

These oracles recommend an entirely different kind of set for their friends than they make for themselves. Although 16 per cent. of those who replied had made one form or another of the Roberts receiver, this popular type by no means was recommended most frequently to inquiring friends, who were probably those in the market for a factory-built outfit. These radio enthusiasts realize that a beginner does not get good results with a receiver requiring more than average skill to operate. 34.6 per cent. recommended the super-heterodyne to their friends, 29.5 per cent. tuned radio-frequency receivers, and 17.2 per cent. neutrodyne receivers.

Take another look at Mr. Average Listener. Notice those keen, searching eyes, those little wrinkles just over the nose. Any physiognomist will tell you that these indicate concentration and an insatiable appetite for knowledge. This characteristic is almost uniform among radio enthusiasts. They want Radio Broadcast's Laboratory to work day and night finding out things for them that they want to know. You would guess, of course, that they ask for the development of a lot of new circuits to play with. But that is not altogether the right guess. The request most frequently made in the answers to the questionnaire was for technical investigations and laboratory reports regarding the qualities of radio sets and parts. What they want is performance data so that, when they are consulted, they really know what they are talking about. They want to be able to say that the "Cream Puff receiver has 25 per cent. greater amplification in the radio-frequency amplifier than the Stuffed Doughnut receiver, but the latter has a much better audio-frequency



"FANS FLOCK TO THE GOOD RADIO STORE"

amplifier, maintaining, as it does, practically a straight-line characteristic between 32 and 5300 cycles."

Fourteen and two-tenths per cent. want information about the construction of accessories such as A and B battery eliminators, loud speakers and other elements which improve existing sets; 13.2 per cent. on the fundamentals of set and circuit operation; 11.8 per cent., more information on specific kinds of circuits with the super-heterodyne as the leader receiving 4.9 per cent of the vote in this section. Ten and one-tenth per cent. asked for more short-wave experiments, radio pictures, and beam transmission. Eight and one-tenth per cent. asked advice on how to make sets with specific qualities such as simple tuning, one-control, more sensitive sets.

Seven and seven tenths per cent. of those replying to the questionnaire were interested in transmission phenomena, investigation of fading, causes and cures for static and power line interference.

THEY WANT FORWARD STEPS IN RADIO

THERE was no such diversity of interest however in regard to the problems of radio which they wanted the magazine to fight for.

Let the blooper beware! We find his life is seriously endangered. Thirty-five and five tenths per cent. favor capital punishment in various forms for the blooper, ranging from gentle dynamiting to "something lingering, with boiling oil in it." We do not publish some of the phrases used by irate enemies of bloopers, lest suspicion be attached to them, should there be any mysterious disappearances.

Sharing almost equally with the bloopers in the contempt of radio enthusiasts are those little, willful broadcasting stations which insist on inflicting themselves upon the overburdened ether, regardless of the wishes of the radio audience or the good of the broadcasting art. Thirty-two and seven tenths per cent. asked for the wholesale elimination of mediocre stations. Many were specially acrimonious in alluding to some of the newer stations which have filled the ether bands to overflowing. If the owners of such stations believe that they are gaining goodwill, they have certainly made a terrible mistake.

Ten and five tenths per cent. made suggestions for better broadcasting, asking for the encouragement of better programs, less prolific announcing, better pronunciation in announcing, less jazz, and better quality in transmission. The other program movements favored received only a scattering vote. It is notable in this respect that there were practically no protests against commercial broadcasting.

GOOD PARTS WILL STILL BE MADE AND SOLD

IN ORDER to further aid and enlighten the troubled radio industry, this magazine also questioned parts manufacturers and dealers as to their opinion on the future of the parts business. Radio enthusiasts are often surprised to learn from their dealers that they are giving up the parts business because it is more trouble than it is worth; at the same time, they find the business in the really active and enthusiastic parts store bigger and better than ever. What is the true situation? Is the number of retail outlets for parts gradually becoming comparable in number to those existing for steam calliopes or ostrich harnesses?

The figures obtained by Radio Broadcast indicate a very pleasing and definite trend in the parts business. Thirteen and nine tenths per cent. of the dealers handling parts last year are or have given it up during the coming season. Yet 24 per cent. reported substantial increases in parts sales during the last season. It was necessary to study the individual questionnaires in order to get at the root of the situation. In every case that a dealer indicated that he was interested and enthusiastic about set construction, about the handling of parts and sympathetic with the experimenter, and stated that he equipped his store so as to handle parts to advantage, including in his staff, technical men capable of advising and helping enthusiasts, the parts business grew and grew. Fans are quite evidently flocking to the man who caters to them by helpful service and neglecting him who stocks parts as an evil necessity.

All the manufacturers who developed and actively marketed new devices specially adapted to making the latest and most advanced types of sets found the parts business profitable and growing. This included 75 per cent. of those answering the questionnaire. But those who rested on their laurels and did not contribute to the advancement of home set building did not find their coffers flooded as the result of an insistent demand for their products.

It is obvious from the foregoing that set building has gradually consolidated its following in what, by all evidence it is possible for us to gather into a group of serious and persistent experimenters and that only those catering to their special interests—whether dealers or manufacturers—can gain their liberal patronage. But if he makes or markets products which enable the constructor to make the best and latest there is in radio, his ingenuity and progressiveness will be rewarded with profit.

From our study of the replies returned from the leading parts manufacturers, it is certain that the interested home constructor, whose numbers still remain legion, may continue to expect an ever improving selection of parts and that there will be constantly improved components for his favorite model of receiver, B power supply and all the other essential parts and accessories. There is no question whatever that progressive designs put forward by manufacturers known to all in the field will be widely purchased by the discriminating set building enthusiast.

TWO INTERESTING RECEIVERS SHOWN IN THE FALL EXHIBITS

On the left is an interesting Erla model using the circuit developed by the Radio Frequency Laboratories. The model below, from F. A. D. Andrea, New York, is a three-control long-wave neutrodyne receiver, especially developed for the British and Continental market. The set, as will be noted has anti-capacity telephone switches for changing from short to long waves. The set will tune well above 2000 meters

★ Tested and approved by RADIO BROADCAST ★

The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of Radio Broadcast *have until recently been answered either by letter or in "The Grid." The latter department has now been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," we present herewith a series of Laboratory Information Sheets. These sheets contain much the same type of information as has appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* Radio Broadcast *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 585 of this issue. Some of the former issues of Radio Broadcast, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 33 Radio Broadcast Laboratory Information Sheet October, 1926

Tandem Tuning

EQUALIZING THE CIRCUITS

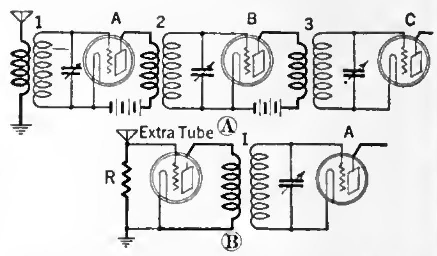
TANDEM tuning of condensers, to decrease the number of separate controls, has become quite common. There are some fundamental facts concerning tandem tuning which must be considered if satisfactory results are to be obtained.

The output and input characteristics in which the tuned circuits work must be the same in each stage. In A of the accompanying diagram, the tuned circuit No. 2 works out of the plate circuit of one tube and into the grid circuit of the following tube. The same thing is true of circuit No. 3. Therefore, if the coils and condensers are exactly similar, the two condensers in these circuits may be coupled together and operated from a single control. The tuned circuit No. 1, however, is coupled to an antenna, and for this reason its condenser will not tune in exact step with the other two condensers and, therefore, it cannot be "ganged" with the other two circuits even though the coil and condenser have the same characteristics.

One method which will permit the ganging of all three condensers is shown in B. Here, tuned circuit No. 1 has been coupled to the plate circuit of an additional tube. It is now similar to the other two tuned circuits, and the three can be all tied together. The antenna then feeds through a resistance coupled directly to the grid of the additional tube.

It is, of course, possible to so construct circuit A so as to permit ganging of all three units without an additional tube. It would require, however, very accurate cutting of the condenser plates so as to compensate any effect of the antenna circuit. This is a difficult job and it is preferable to either retain two controls or to use an extra tube.

Many so-called single-control receivers are equipped with some compensating device which



permits exact tuning of each circuit to resonance. In some cases this device consists of a small midget condenser connected in parallel with one of the main tuning elements; sometimes the stationary plates of one of the condensers are mounted on a pivot so as to permit more accurate tuning. But no receiver that has such an adjustable feature can accurately be called a single-control set.

No. 34 Radio Broadcast Laboratory Information Sheet October, 1926

Series Connection of Filaments

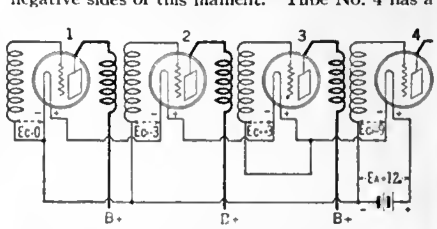
BIAS FROM VOLTAGE DROP

ALTHOUGH the practice of connecting filaments in series has been common in telephone work for some time, it has only lately come into use among radio set builders.

When filaments are in parallel, the battery voltage must be the voltage that one tube requires. For a 201-A type tube this is five volts. When the tubes are in series the battery voltage must be the sum of the voltages, that is, for five 201-A type tubes, 25 volts is required. In the parallel case, the total current is the sum of that taken by each tube; in the series case, the current is that taken by one of the tubes.

In the diagram are four 199 tubes in series with a 12-volt battery to supply them with current. There is a three-volt drop in each filament and, taken from the positive end of the battery, the total drop increases in three-volt steps. This voltage drop can be used as a negative bias for amplifier tubes. It is only necessary to connect the grid return of the amplifier in question to the place along the line where the voltage—with respect to the negative side of the amplifier filament—is that required for proper bias.

For example, in the diagram, tube No. 1 has its grid return connected to the negative side of the filament. This represents zero bias. Tube No. 2 is also connected to the same place, but between the negative side of the filament of tube No. 2 and the point where its grid return is connected, is a three-volt drop caused by the preceding tube. In the same manner, tube No. 3 has its grid biased positively three volts since in this case there is a difference of voltage of three between the positive and negative sides of this filament. Tube No. 4 has a



negative bias of 9 since between its negative filament lead and the point where its grid return is connected is the voltage drop caused by three preceding tubes. In the diagram, Ec represents grid volts. In the article entitled "An A. B. C. Line Supply Device" in the October, 1926, Radio Broadcast, diagrams are given of receivers with filaments in series.

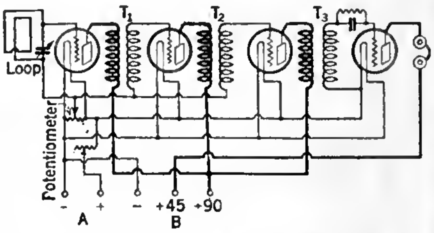
No. 35 Radio Broadcast Laboratory Information Sheet October, 1926

Radio Frequency Transformers

TUNED AND UNTUNED

Radio frequency transformers are classified as "tuned" or "untuned." A tuned transformer must be tuned to the frequency that is to be amplified. Thus, for a particular setting of the condensers, the amplification would be great for a narrow band of frequencies but negligible for frequencies even slightly outside of this band. Untuned transformers, despite the fact that they are called "aperiodic," work best at some particular frequency. However, they are supposed to work over a wide range of frequencies. The wide range is due to the introduction of resistance, or, if iron cores are used, by a combination of the advantage of the iron core with the effective resistance introduced into the transformer by the losses that occur in iron at high frequencies. In general, it may be said that, when there is much resistance or anything else that causes losses, the amplification will be less than that theoretically obtainable by the use of tuned transformers. A few stages of tuned transformer-coupled amplification have the advantage of giving great selectivity, that is, amplifying only one frequency (strictly speaking, only a very narrow band of frequencies) but have the disadvantage that as each stage must be carefully tuned, it is complicated to change from one frequency to another and difficult to pick up weak signals unless the proper setting for each tuning condenser is known in advance. In the super-heterodyne system, this disadvantage disappears because the intermediate-frequency amplification is done at a fixed frequency, irrespective of the wavelength of the station being received.

The diagram shows a typical three-stage untuned transformer-coupled r. f. amplifier with potentiometer stabilization. The transformers are marked



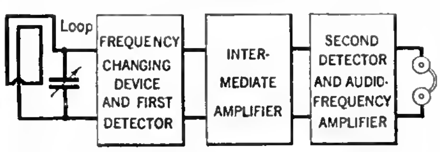
T_1, T_2, and T_3. Receiving sets of this type are not very selective as there is only one tuned circuit to do the "selecting," but they are easy to operate as the tuning condenser and the potentiometer are the only controls. Unless an arrangement for plugging-in different transformers is provided, the range over which best amplification is obtained is usually only about two hundred meters.

No. 36 Radio Broadcast Laboratory Information Sheet October, 1926

The Super-Heterodyne

ACTIONS AND PRINCIPLES

Essentially, the super-heterodyne consists of a receiver constructed to receive on one single frequency (whatever frequency it is most efficient to work with), ahead of which is a frequency changing device in combination with a detector tube (known as the first detector) designed to change the frequency of the incoming signals to that of the fixed frequency receiver. The receiver designed to receive on one single frequency consists



of several r. f. stages (known as the intermediate-frequency amplifier), a detector (the second detector), and the usual audio amplifier.

The tuning controls consist of two variable condensers, one to tune the loop to receive the incoming signals (which are passed to the grid of the first detector), and the second to tune the frequency changing device (known as the local oscillator).

It is a well-known fact that two frequencies, if superimposed, will produce a third frequency, its value equalling the difference between the two superimposed frequencies. The object of the local oscillator is to produce locally a frequency which may be superimposed upon the incoming frequency. The frequency of the locally generated wave must be such that when it heterodynes (is superimposed) with the incoming signal, the third frequency will equal that which is capable of being received by the fixed frequency unit of the super-heterodyne. This third frequency may be 30 kc. Thus we hear mention of a 30-kc. super-heterodyne, which means that its intermediate amplifier is designed to pass signals of only that frequency.

A very realistic example of the super-heterodyne principle may be obtained any night these days by listening-in to the shorter wave broadcasting stations. Often the program is marred by a constant howl which may vary slightly in pitch. This is caused by two broadcasting stations straying from their allotted frequencies and heterodyning with each other, thereby causing an audible howl. This is known as "beating." The third frequency produced by the heterodyne action in such a receiver is known as a "beat" note.

The accompanying diagram makes clear the sequence of units in the super-heterodyne. In some receivers of this pattern, r. f. amplification is resorted to ahead of the first detector and frequency changing unit. Further details of the super-heterodyne appear on Sheet No. 41.

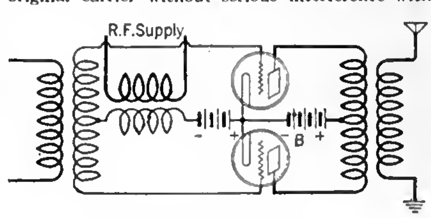
No. 37 Radio Broadcast Laboratory Information Sheet October, 1926

Single Side Band Transmission

A SIMPLE EXPLANATION

The carrier wave plays no important rôle in the actual conveyance of intelligence. It is required only for the purpose of modulation at the transmitting station and of demodulation at the receiving end. For actual transmission it may be left out entirely, only the modulated component being transmitted, provided that a local oscillator tube is used at the receiving end to supply current of the same frequency to take its place. The "balanced modulator," used to get rid of the carrier, is shown in the diagram. Analysis of this circuit (which consists merely of two tubes, each acting as an oscillator) shows that the two side bands generated by each tube act additively in producing current in the antenna, but the carrier frequency current in the plate circuit of one tube just cancels the effect of the carrier current in the other tube, as far as producing current in the antenna is concerned. Much power is wasted transmitting the carrier, but for most purposes it is best to do so because it is difficult to make the local oscillator at the receiving station supply just exactly the same frequency. Another advantage in suppressing the carrier is that the locally generated carrier frequency at the receiving end is not subject to variations in strength, and hence there is a reduction in the amount of fading of the received signals.

Furthermore, only one of the side bands is required to convey the speech or music, and, therefore, the channel required will only be one half as wide, which is an important feature if the ether is crowded with transmitting stations. Also, the receiving set can be made to receive only one half as wide a band of frequencies and hence offers only one half as much chance for interference to get in. If both the carrier and one side band are suppressed, the local oscillator at the receiving end can be as much as fifty cycles different in frequency from the original carrier without serious interference with



intelligibility of speech. However, the harmonic ratios in music would suffer. For the reasons mentioned above, the American Telephone and Telegraph Company is using single side band transmission in its transatlantic telephony tests. This system is not now practicable for short-wave work as it is too hard to "filter out" the side band that is not wanted when the width of these bands is only a small fraction of the carrier frequency.

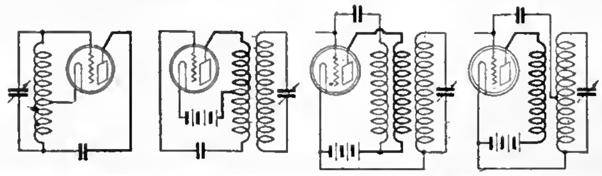
No. 38 Radio Broadcast Laboratory Information Sheet October, 1926

Neutralization

WHAT IT ACCOMPLISHES

THE best way to prevent oscillation in an r. f. amplifier is by the "bridge," or "capacity neutralization" method. When this system is used, the variations of plate potential which are caused by the grid variations (which, in turn, may be caused by the incoming signal impulses) do not react upon the grid circuit and cause feedback. The method will be better understood if prefaced by a brief statement of what happens when the bridge is *not* used. The alternating current in the plate circuit flowing through the impedance, or "load," (such as a transformer primary) in the same circuit, produces an alternating potential-difference between plate and filament. This potential difference cannot exist without causing currents to flow from plate to filament by every possible path. One such path is from the plate to the grid through the grid-plate capacity of the tube, thence from the grid to the filament through the grid circuit. Now, this current flowing through the impedance of the grid circuit produces an alternating potential difference between grid and filament. As the impedances of both the plate circuit and the grid circuit probably contain inductance, regeneration will result, and if enough inductive reactance is introduced into the plate circuit (for example, by tuning a secondary circuit coupled in any way to the plate circuit), oscillation will take place.

Considering what causes the regeneration or oscillation, it is easy to see that it can be eliminated by connecting a small condenser in such a fashion that the current flowing through it affects the grid to an extent just equal but exactly opposite in nature to the effect of the current flowing through the grid-plate capacity. This may be accomplished in a number of ways, a few of which are shown in the diagram.



In every case, the current flowing through the neutralizing condenser to the filament does away with the effect of current flowing through the grid-plate capacity provided the neutralizing condenser is adjusted to the proper capacity. For the sake of variety, the tuning condenser has been shown in several positions. It can be put across either part of any of the split coils, or across the whole coil, or across a separate coil coupled to the split coil.

The positions shown are the more commonly used ones.

No. 39 Radio Broadcast Laboratory Information Sheet October, 1926

Field Intensity Measurements

HOW THEY ARE MADE

IN A recent report by the Bureau of Standards, the following method of measuring the field intensities of broadcasting stations is suggested.

The method can be used for distances up to about fifty miles, and will give correct results at broadcast frequencies. For greater distances than fifty miles it gives approximately the maximum value of field intensity (not the average value) reached by waves subject to fading. The method makes use of what is termed the radiation constant. This constant is determined by making field intensity measurements at not less than five points distributed fairly evenly around the transmitting station at a distance of about ten miles. The radiation constant is then expressed as the average field intensity at ten miles in millivolts per meter.

The radiation constants of several stations are given below:

STATION	RATED POWER, kw.	RADIATION CONSTANT
KDKA	10	43
KFKX	2	28
WEAF	3	32
WHAS	0.5	5
WCAP	0.5	17
WLW	5	31

With the field intensity at ten miles known, the resultant field intensity at any other distances is given by the formula:

$$F = \frac{10}{d} F_{10} \qquad (1)$$

where F_{10} is the radiation constant and F the field intensity at any other distance. This value of F neglects any ground absorption and gives correct results up to about fifty miles, as mentioned above.

To make a measurement a receiver is set up and a milliammeter placed in the output of the detector circuit. The deflection of the needle is observed when signals from the base station—the radiation constants of which are known, are being received, and then the receiver is re-tuned to the station on which it is desired to make the test, and the deflection noted again. The field strength can be determined by substituting in the formula given below:

$$F = \frac{R}{R_B} \times \frac{I}{I_B} F_B \qquad (2)$$

where R is the resistance of the receiving antenna, at a frequency corresponding to the transmitted signals of the station under test; R_B is the resistance of the receiving antenna at a frequency corresponding to the signal from the base station; I, the deflection on the signal from the test station; I_B, the deflection on the signal from the base station and, F_B, the field intensity of the base station determined by formula No. 1. The derivation of formula No. 2 will be found on Laboratory Information Sheet No. 43.

No. 40 Radio Broadcast Laboratory Information Sheet October, 1926

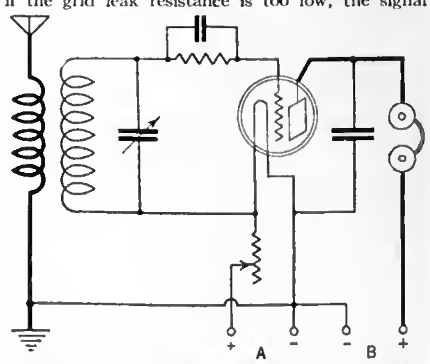
Analysis of Detection

THE REASON FOR THE GRID LEAK

A METHOD of detection commonly used makes use of a grid leak and condenser. The operation of the circuit may be roughly outlined as follows:

In the absence of incoming waves, the potential of the grid is the same as that of the filament. Incoming waves cause the grid to become alternately more positive and more negative than the filament. While the grid is more negative, nothing happens, but while it is more positive it attracts negative electrons. These electrons cannot get off the grid once they are on it (the grid is not hot like the filament) except via the high resistance which is called the grid leak. If, for the moment, we suppose there is no grid leak provided, we can see that after a very few waves have come in, the electrons drawn to the grid will charge it to a steady negative potential equal to the maximum instantaneous potential of the top of the coil in the antenna circuit. This steady negative potential causes a reduction in the plate current. Even if the waves cease coming in, or their amplitude is diminished, the grid retains its negative charge since there is no way for the electrons to get off it. So we put in a very high-resistance path by which they may slowly (compared to the wave frequency) escape so that, if the amplitude of the incoming waves slowly (*i.e.*, at voice frequency) diminishes, electrons will leak off until the grid potential drops to the new maximum value of potential at the upper end of the coil. In this system, the greater the strength of incoming waves the less the plate current. The connections shown in the diagram are often recommended.

The size of the grid leak is more or less important. If its resistance is too great it is possible that the grid of the tube will block on strong signals, whereas if the grid leak resistance is too low, the signal



strength will be decreased. For the ordinary 201-A type tube, a grid leak of about four megohms resistance will give the best results. If a soft detector tube is used, a somewhat lower resistance leak is generally required; about one half to two megohms being about right.

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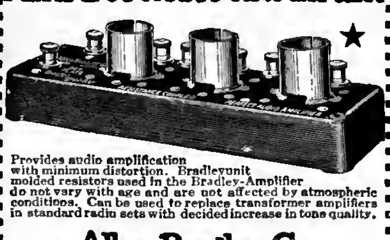

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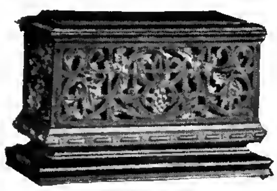

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Built on an entirely new principle of *balanced* construction and exceptionally responsive to the weakest signals, the new Amplion reproduces the entire vocal and musical range with an astonishing purity, combined with the utmost volume.

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Who Is To Control Broadcasting?

The Present Status of Radio Legislation—Why Secretary Herbert Hoover Renounced Absolute Control of Broadcasting

By THOMAS STEVENSON

HAVING guided broadcasting through its early stages of development until the adjournment of the First Session of the Sixty-Ninth Congress, almost overnight Secretary of Commerce Herbert Hoover renounced the so-called rôle of "traffic cop of the ether."

On the surface, two events alone were apparently responsible for the announcement by Mr. Hoover that the Department of Commerce would make no further attempt to assign wavelengths and regulate times of operation and power of stations.

These were the decisions of the Federal Court for the Northern District of Illinois, and of the Department of Justice, that any station is at liberty to use any wavelength at will, so long as trespass is not made upon the band from 500 to 187 kc. (600 to 1600 meters).

There was another factor—one that cannot be found in the record, and which is received with a fine display of scorn by Mr. Hoover and his staff assistants. It is the keen disappointment of Herbert Hoover over the failure of Congress to extend to him a vote of confidence in appreciation of his efforts in bringing broadcasting through the swaddling clothes and teething periods.

Equally disappointing to Mr. Hoover was the failure of the broadcasters to rally to the defense of the principles to which they unanimously committed themselves at the Fourth National Radio Conference.

For more than four years Mr. Hoover has been the "guiding genius" who has enabled the United States to make greater progress in the development and commercial and social use of broadcasting than any other country of the world. Through a system of self-regulation, worked out by annual national radio conferences, broadcasting in the United States has been unhampered by the laws and regulations which so often in the past have prevented the natural growth of many industries.

An extract from his address in opening the Fourth National Radio Conference clearly shows his pride in the success of the self-regulating experiment. Mr. Hoover said:

> We have great reason to be proud of the results of these conferences. From them have been established principles upon which our country has led the world in the development of this service. We have accomplished this by a large measure of self-government in an art and industry of unheard of complexity, not only in its technical phases but in its relation both to the government and the public.
>
> Four years ago we were dealing with a scientific toy; today we are dealing with a vital force in American life. We are, I believe, bringing this lusty child out of its swaddling clothes without any infant diseases, and that is more than can be said of any other invention or industry that has developed in this country.
>
> We have not only developed in these conferences traffic systems by which a vastly increasing number of messages are kept upon the air without destroying each other, but we have done much to establish the ethics of public service and the response of public confidence.

Increasing problems, due to rapid development, however, made imperative new legislation to take the place of the 1912 Radio Act, which was enacted before broadcasting was dreamed of. Mr. Hoover had purposely requested Congress to defer radio legislation until development progressed sufficiently to indicate the kind of law that might prove most beneficial to the industry and the public.

At the beginning of the last session, Mr. Hoover went to Congress with the views of himself, the industry, and the public, as to the sort of legislation that was needed. Mr. Hoover recommended the enactment of a law that would provide authority for the limitation of stations, and regulation of power and time division along lines compatible with the "public interest, necessity, and convenience."

SECRETARY OF COMMERCE, HERBERT HOOVER

Mr. Hoover suggested that the details of enforcing the radio law be entrusted to the Department of Commerce, but that there be appointed a Commission of five members with authority to pass finally upon any matter referred to it by the Department of Commerce, or any one else affected. The Commission would not be in continuous session but would meet only upon call of the chairman or when matters were referred to it for decision.

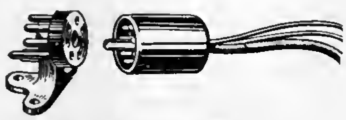
Outlining the necessity for such a commission, Mr. Hoover said:

> We have, in the regulation of broadcasting a question of discretionary authority that may affect the right, the good will, the property, and freedom of individuals, that should never be vested in one single official of the Government; that is a point in government where a number of deliberative minds should be called into action.
>
> In the whole of our government plan—the plan of the original Federal Government under the Constitution—we were most jealous to divide the authority of the government in such fashion that the judicial and legislative questions should rest in the hands of many men and not in the hands of administrative and executive officers.

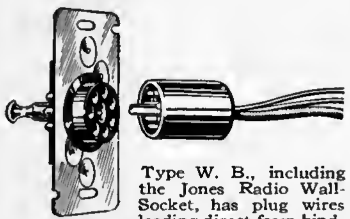
There is One Best Way

Jones MULTI-PLUG, the Standard Set Connector, is illustrated below in its various models. To-day the discriminating buyer chooses a set MULTI-PLUG equipped or immediately equips his own set with the MULTI-PLUG because it affords greater simplicity, safety and more convenience than any other method used to connect the radio receiver with the current supply.

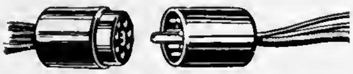
Type P. M. is mounted right in the panel. Plug leads go to batteries, ground and aerial.



Type B. M. is mounted on the base and wires are soldered to back of socket posts; no binding posts are necessary.



Type W. B., including the Jones Radio Wall-Socket, has plug wires leading direct from binding posts; plug goes into wall socket. Wall socket is connected with hidden batteries, ground and aerial. Adapted to any set.



Type B. P. is adapted to any set. The wires from the socket lead to the binding post, while the wires from the plug lead to the batteries, ground and aerial.

Double Plug Cable is used when both set and current supply are equipped with Jones Sockets.

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THE WHITE AND DILL BILLS

IN BOTH the Senate and House, bills were introduced incorporating the recommendations of Mr. Hoover—by Senator C. C. Dill, Democrat, of Washington, and Representative Wallace White Jr., Republican, of Maine.

During public hearings by the House Merchant Marine and Fisheries Committee, to which the White bill was referred, opposition developed among a number of Democratic members to some of Mr. Hoover's suggestions. Headed by Judge Ewin L. Davis, Democrat, of Tennessee, the Democrats urged establishment of a new commission to have entire jurisdiction over the regulation of radio, and the imposition of drastic anti-monopoly safeguards.

During discussions of the subject, no criticism was voiced toward the administration of Mr. Hoover, but the view was expressed that the White bill was a "half baked" proposition, and, if enacted, would have to be revamped within a few years.

With no thought of attempting to belittle the efforts of his colleagues, a prominent leader of the Democratic party gave this explanation of the minority point of view:

"Oh, they just want to be different from the Republicans!"

Despite Democratic protests, the White bill passed the House in the form recommended by Secretary Hoover without a record vote.

At about the time the Senate Interstate Commerce Committee took up the Dill bill, the Department of Commerce began proceedings against the Zenith Radio Corporation for alleged "piracy" of a wavelength. Decision of this case in favor of the Chicago broadcaster emphasized the necessity for legislation, and the subject received more time and attention in the Senate than might otherwise have been accorded it.

The chairman of the Senate Interstate Commerce Committee is James E. Watson, Republican, of Indiana. Mr. Watson is considered a politician of the highest rank and he has been told that he would make a "distinguished looking president."

Although Senator Watson admits he does not know anything about the technical side of radio, he shrewdly suspects it holds tremendous political possibilities. Even the suggestion of chaining such a force to the bidding of a political competitor would cause a look of horror to overspread his usually placid face.

Despite objections by the President, Senator Watson felt it incumbent upon himself to support the complete divorce of radio from the Department of Commerce and Secretary Hoover. His argument was that: "Secretary Hoover already has enough to do to keep him busy without tackling radio." It might be noted that the Department of Commerce has "tackled radio" ever since the first days of an American radio law, and that in his Department, has grown and developed, the complete machinery and trained personnel to enforce a complicated statute.

Keen to take advantage of the opening offered by the refusal of Senator Watson to follow the wishes of the President, the Democrats and insurgent Republicans gladly rallied around the banner of the Indiana Senator. If the regular Republicans in the Senate had gone to the support of the President, the story might have been different. But not one of them spoke a word in defense of the Chief Executive and his Secretary of Commerce.

To complicate matters, the broadcasters adopted a "hands off" policy. They left it entirely to Congress to pass a law and to Secretary Hoover to see that the proper kind of law was passed. Furthermore, a number of the broadcasters were quoted as expressing the view that Secretary Hoover had overstepped his authority, and that he had shown discrimination toward certain companies in the allocation of wavelengths.

Following the Watson lead, Senator Dill entirely rewrote his bill and the new product provided for the establishment of an independent commission for the regulation of radio. After a few executive sessions, this bill was unanimously reported to the Senate for passage.

Although the Dill bill was reported to the Senate early in May, it was not taken up until the last week before adjournment. The thought was that the measure could be passed in short order and the differences between it and the White bill adjusted in conference in time for enactment. This scheme might have worked out but for the objections of Senator Cole Blease, Democrat, of South Carolina.

Asserting that he would "Want to know the religion of the Commissioners" and whether "they would favor the teaching of evolution by radio" before he would consent, Senator Blease forced a delay of one day, thereby preventing the bill from reaching conference until late the day before adjournment.

The Dill bill passed the Senate without a record vote, although a number of the members of that body expressed disapproval of some of its provisions and the hope that they would be eliminated or changed in conference.

With only a few hours to work, the Conference agreed to disagree, and an effort was made to pass an emergency resolution which would limit broadcast licenses to ninety days until the enactment of a new law. During the last minute jam even this failed of enactment because the Vice President did not have time to sign it.

SECRETARY HOOVER DISPLEASED

DURING consideration of radio legislation in Congress, Secretary Hoover was not particularly pleased at the implied reflection on himself by the move to take radio away from the Department of Commerce. He felt that he had done his job well and that his department was entitled to more consideration.

Although no one in the Department of Commerce will admit it, there is good reason to believe that even Mr. Hoover and his legal staff have been in some doubt as to their authority to enforce some of the recommendations of the national radio conferences which were put into effect for the benefit of the industry and the public.

There is no doubt in the minds of a number of people in a position to know, that the Department of Commerce might have been able to "carry on" during the summer despite the decision of the Chicago Court.

But, smarting from the criticisms of Congress and a number of the broadcasters, Mr. Hoover did not feel justified in attempting to shoulder the burden any longer. Therefore, he asked the Department of Justice for a ruling on the matter, realizing as he must have, what the decision would be. Upon receiving the Department of Justice ruling which upheld the Chicago Court decision, Mr. Hoover announced that the Department of Commerce would make no further attempt to regulate the wavelengths, time of operation, and power of stations. Referring to the Department of Justice ruling, Mr. Hoover said: "The general effect of this opinion is that regulation has broken down and stations are under no effective restriction as to wavelength or power used. The 1912 Act, under the various constructions, has failed to confer authority for the prevention of interference, which was its obvious intent."

The country now has to await such action as Congress may see fit to take when they reconvene this fall. Meanwhile the broadcasting situation is being "investigated" by many organizations, including the American Engineering Council and the National Better Business Bureau.

Constant and Standard Frequency Radio Stations

THE radio broadcasting situation is being stabilized in part by the frequency measurements of the Bureau of Standards, Department of Commerce. The friendly rivalry of broadcasting stations, which maintain their frequencies with high accuracy, for places on the Bureau's honor roll, is augmented by an announcement just made of a new list of stations. This new list includes stations which use special means of maintaining constant frequencies and which have given evidence of holding their frequencies accurately on the assigned values by the use of special devices for that purpose. The transmitted waves from these constant frequency stations are therefore of value to the public as frequency standards. The special devices for frequency regulation employed by the constant frequency stations include piezo oscillators, piezo resonators, and frequency indicators. The list below of constant frequency stations now supplements another list which the Bureau of Standards has been publishing monthly since November, 1923.

The list of standard frequency stations includes transmitting stations which have actually been found by measurements made in the Bureau's laboratory to maintain their frequencies very constant and close to the assigned values. The number of these stations is necessarily limited because of the practical difficulties involved in measurements of this kind which can be made at one place.

The use of the piezo oscillator and the frequency indicator, specifications for construction of these devices, and information on methods of utilizing the waves from any of these stations as frequency standards, are all covered in pamphlets obtainable on application from the Bureau of Standards

CONSTANT FREQUENCY STATIONS

STATION	LOCATION	ASSIGNED FREQUENCY (KILO-CYCLES)
WOC	Davenport, Iowa	620
WTIC	Hartford, Connecticut	630
WMAQ	Chicago, Illinois	670
WCCO	Minneapolis-St. Paul, Minnesota	720
WWJ	Detroit, Michigan	850
WLS	Crete, Illinois	870
KTAB	Lincoln, Nebraska	880
WJJD	Mooseheart, Illinois	990
WEAO	Columbus, Ohio	1020
KFKA	Greeley, Colorado	1100
KFH	Wichita, Kansas	1120
WENR	Chicago, Illinois	1130
WCAD	Canton, New York	1140
WAAM	Newark, New Jersey	1140
WSKC	Bay City, Michigan	1150
WOWO	Ft. Wayne, Indiana	1320
WBBM	Chicago, Illinois	1330
WEBQ	Harrisburg, Illinois	1330
KFVS	Cape Girardeau, Missouri	1340
WOK	Homewood, Illinois	1380
WPDQ	Buffalo, New York	1460

STANDARD FREQUENCY STATIONS

STATION	LOCATION	ASSIGNED FREQUENCY (KILO-CYCLES)
NSS	Annapolis, Maryland	17.50
WCI	Barnegat, New Jersey	17.95
WGG	Tuckerton, No. 1, New Jersey	18.86
WII	New Brunswick, New Jersey	21.80
WRT	New Brunswick, New Jersey	22.60
WVA	Annapolis, Maryland	100.00
NAA	Arlington, Virginia	112.00
WEAF	New York, New York	610.00
WCAP	Washington, District of Columbia	640.00
WRC	Washington, District of Columbia	640.00
WJZ	Bound Brook, New Jersey	660.00
NAA	Arlington, Virginia	690.00
WGY	Schenectady, New York	790.00
WBZ	Springfield, Massachusetts	900.00
KDKA	E. Pittsburgh, Pennsylvania	970.00
KDKA	E. Pittsburgh, Pennsylvania	4711.00

Further details concerning the stations are given in the July issue of the Radio Service Bulletin, a monthly publication of the Department of Commerce, obtainable from the Superintendent of Documents, Government Printing Office, Washington, District of Columbia, for 25 cents per year

How to Improve Your Neutrodyne

Some Easily Made Changes Which Will Put Last Year's Neutrodyne on a Par With Later Models

By THORP HISCOCK

UNDOUBTEDLY the first step to be taken in revamping the neutrodyne of last year lies in the audio amplifier stage of the receiver. Modern requirements call for improved output quality, and this is now made possible with the new transformers and tubes available. The often neglected question of grid bias is also nowadays receiving its full quota of attention—better late than never.

To increase the sensitivity of the set, and also, to a certain degree, the selectivity, the addition of properly controlled regeneration is sufficient. Regeneration is equal in amplification to about two stages of tuned non-regenerative radio frequency amplification.

The particular method used here to affect regeneration and properly control it, is open to much discussion. However, most of the ways generally known necessitate a fourth main control which is quite critical in adjustment and, to be of any real advantage, demands a resetting each time the set is re-tuned. The method to be followed in this article, however, is not at all critical, and is very smooth and positive in action, and needs only slight adjustment to keep the set working at maximum sensitivity.

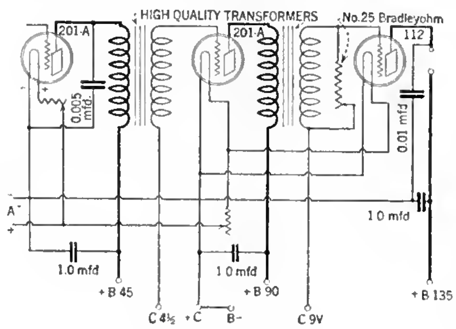


FIG. 1

Here are shown all the changes that are necessary to modernize the audio-frequency amplifier unit of the neutrodyne receiver as described in the text

Should the addition of regeneration not increase the selectivity sufficiently, it is only necessary to loosen the antenna coupling, and subsequently the interstage couplings, until a degree of selectivity sufficient to work through the local stations is obtained.

In this discussion of the neutrodyne, it must be taken for granted that the set is already properly stabilized, and that it has no tendency to oscillate at the low end of the scale when the tubes are burned at their rated voltage. The set owner who knows anything about radio at all, and is handy with a soldering iron and pliers, can make his own changes with little or no trouble. The changes are outlined in steps, and it is advisable to operate the set after each step is completed to mark the increase, and to be sure that no wrong connections are made.

PUTTING IN NEW TRANSFORMERS

IN THE matter of audio frequency transformers, it is suggested that those of General Radio, AmerTran, Rauland Lyric, Thordarson, or Jefferson be used. There are other new makes of audio transformers on the market, all just as satisfactory for use in the neutrodyne receiver.

Resistance-coupled audio frequency amplification could be used but it would entail the inclusion of another tube.

The first step is to replace the first-stage audio frequency transformer with a General Radio type No. 285, or similar instrument. The terminals are plainly marked and the substitution is easily made. If the small mica fixed condenser probably already across the primary of the transformer is not one of 0.005 mfd. or 0.006 mfd. replace it with one of approximately 0.005-mfd. capacity. This condenser may be connected from the plate terminal of the detector tube to the negative filament terminal of the same tube. It will later be changed but, for temporary operation while checking, it should be installed as though it were to be permanent. A bypass condenser of 1.0-mfd., or more, should be installed between the plus B terminal of the transformer and the nearest negative A battery lead to bypass the alternating current around the detector B battery, and to keep it out of the long battery leads.

If a C battery is not already in the circuit, one should be inserted. The Burgess 7½-volt type is advisable since a high plate voltage can then be used to advantage in the last stage if desired. This battery may be located anywhere there is room for it in the set since the length of the leads in this case is of little consequence. The positive terminal of this battery is connected to the negative A battery lead. The lead which originally connected to the minus F terminal of the transformer is broken, and in its stead a flexible lead is run from this minus F terminal to the proper negative tap on the grid battery, this grid-battery tap value depending upon the plate voltage used, as specified in the instruction sheet compiled by the tube manufacturer. For a 201-A type this will be 4½ volts where 90 volts is used on the plate of the first audio frequency amplifying tube. Should the same type of tube and the same voltage be used in the second stage, a flexible lead should also be run from the minus F post of the second audio transformer to the 4½-volt tap on this C battery, after disconnecting the old lead from this transformer.

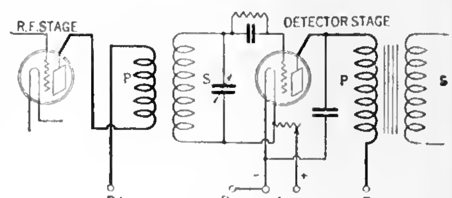


FIG. 2

The detector circuit in its original form looks like the circuit diagram shown here. To include the regeneration feature, it is necessary to revise the circuit as shown in Fig. 3

The C battery may be fastened in position by a strap of bus bar wire cut to proper length, bending an eye in each end to receive a screw. The wire must be so shaped as to pass over the battery and screw down to the base-board on either side.

In some cases, the quality of the output is greatly improved by connecting a resistance across the secondary terminals of the second audio-frequency transformer. This resistance may be a Bradleyohm No. 25, and should be mounted where convenient on the panel, preferably at the right hand end so that the leads will be as short as possible. The connections should be made as close to the transformer as

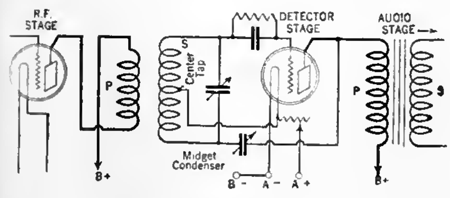


FIG. 3

For the addition of regeneration to the detector circuit, several changes are necessary, as shown. A center tap on the secondary coil must be made and a 13-or 15 plate midget condenser controls regeneration

practicable. The life of a C battery is considerable, but it should be inspected with a meter every six months or so, and if it shows any appreciable drop in voltage, should be replaced immediately. With a dead or low C battery, distortion will be very pronounced, and the B battery consumption will increase.

THE SECOND AUDIO STAGE

THE next step is to substitute a General Radio Company No. 285A or similar second-stage audio frequency transformer for the one now in the circuit. The proper biasing has already been outlined if 201-A tubes are used. If there is not already a 1.0-mfd. bypass condenser between this positive B-battery lead and the negative A battery lead, one should be installed without fail. It is just a few of these little things that make the difference between real reception and the mediocre stuff that in many cases passes as radio reception. When testing out this next step, do not forget to try different adjustments of the Bradleyohm, since this will have a very marked effect both on the volume and quality of reproduction. Also be sure when testing that your batteries are well "up" for there is no use testing a set balanced to operate on a 90-volt plate battery, for example, and then expect it to give good reproduction on 65 or 70 volts.

The total cost of this second step should not exceed $9.00.

PROVIDING FOR THE NEW TUBES

WITH the advent of the semi-power tubes for use in the output stage, it is usually advisable to make provision for their use although the owner may not desire to use one immediately. It is only necessary to remove the lead running from the output jack to where it connects to the B battery plus post (probably 90 volts) and connect the jack to a separate binding post by an individual lead of its own, as outlined above. Thus, any voltage desired can be applied to the output tube without disturbing the voltage on any other portion of the set, extra B batteries, if necessary, being connected in series with those already in use. Provision for increasing the bias on this tube must also be made. To do this, disconnect the lead which was wired, according to previous instructions, from the minus F post on the second audio transformer to where it joins the 4½-volt negative C battery lead. Do not disturb the wiring to the No. 25 Bradleyohm or that to the first audio

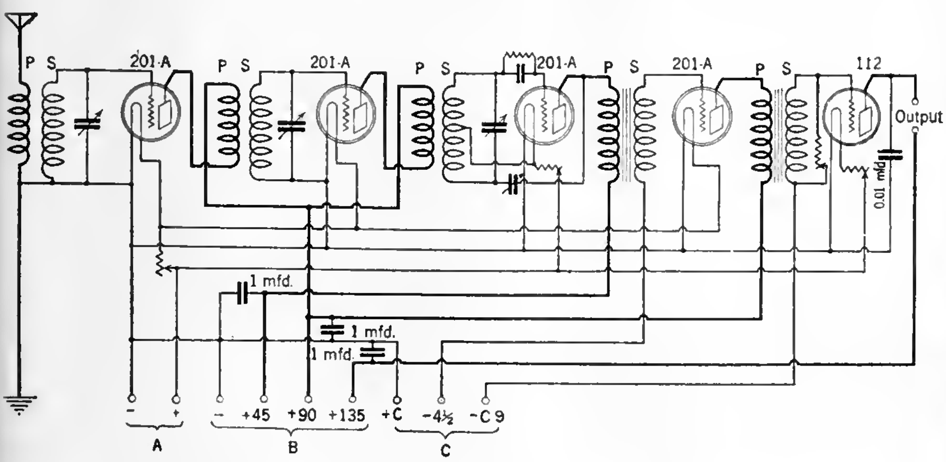


FIG. 4

This is the complete revised neutrodyne circuit with all the advocated changes clearly shown

With some horn type loud speakers a 0.01-mfd. condenser should be connected between the plate terminal of the last tube and the negative filament of the same tube. This results in it being shunted across the output whether that be a jack or a pair of binding posts or both. With some tubes it is found advantageous to include a 0.001-mfd. fixed condenser connected from grid of the second audio tube to the negative terminal of the same socket, but this can only be ascertained by test. The lead from the jack or output post to the positive B battery lead should be disconnected and transferred to a separate battery terminal. A 1.0-mfd. bypass condenser should be connected from this lead to the negative A battery lead to bypass the audio currents around the high resistance of the B battery and the long battery leads. If there is not already a 1.0-mfd. bypass condenser between this positive B-battery lead and the negative A battery lead,

transformer. Now install another binding post and run an individual lead from the minus F post of the second audio transformer to this post. Thus, a negative bias of any voltage can be applied to the last tube by connecting this post to the proper negative terminal on a second C battery of which the positive terminal is connected to the negative A post on the set. When only 90 volts is being used on a 201-A type tube in the final stage, this C post can be connected to the same minus 4½-volt terminal that supplies the first audio tube, and the new B post for the output stage can be supplied from the 90-volt post already on the set, by a jumper.

In employing the type 112 tube, it is well to control its filament by a separate rheostat capable of carrying at least one half ampere. Or, if there is no panel space for a rheostat, a filament ballast unit may be mounted behind the panel to accomplish the desired result.

ADDING REGENERATION

THE first step in adding regeneration is to disconnect the lead from the rotary plates of the third condenser to the A battery lead of the detector tube. The connection from the rotor plates of this condenser to the tuning coil adjacent to it must be left intact. Drill the panel for mounting a midget condenser. Be sure and get the thirteen or fifteen plate condenser, not the smaller ones. Connect the stator plates of this condenser to the rotor plates of the tuning condenser from which you have just removed the connection to the A-battery lead. Connect the rotor plates of the midget condenser to the plate of the detector tube with as short a lead as possible. Take out the 0.005 mfd. condenser that was connected to the primary of the first audio frequency transformer. Next ascertain the middle turn of the secondary of the tuning coil across which the third tuning condenser is shunted. Lift this turn up with a knife blade carefully so as not to injure the insulation on the adjacent turns. The wire will stretch so that it will raise out nicely. Take a sharp knife and scrape the insulation off just far enough to allow a connection to be made and soldered. To protect the winding from injury while soldering, slide a piece of paper under the lifted wire. The other end of this lead goes to the positive A-battery lead where you disconnected the lead from the rotor plates of the tuning condenser. The set is now ready to test again. If by any chance you have a short, the first place to look for it is in the midget condenser since a short here will place the B voltage directly on the filaments.

After the set is hooked up, adjust the midget so that the plates are out of mesh—its minimum capacity position. When mounting this condenser, it is convenient to arrange the knob so that the pointer is horizontal to the right when the plates are all in. This will give the minimum setting horizontal to the left, or "at nine o'clock." Tune-in a station and advance the midget. The detector should go into oscillation with a slight rushing noise and a "plop." After this, only a series of whistles can be received when trying to tune. By reducing the midget setting, the detector comes out of oscillation and reception is resumed. As the midget setting is increased, the volume will increase to a great degree. If the station tuned-in has a frequency of about 600 kc. (500 meters), the set should go into oscillation with the midget set at about "one or two o'clock." Varying the plate battery and filament voltage of the detector tube will correct this to the proper position. As the lower wavelength (higher frequency) stations are tuned-in, the midget will have to be backed off a little to stop the set from oscillating. The setting of the midget will have no appreciable effect on the setting of the third dial after it is once logged, though the readings will vary from those obtained before the circuit was changed. If the detector tube does not oscillate at any setting of the midget, increase the plate voltage and filament voltage to normal. The tube, if not faulty, must oscillate under these conditions.

Coming Articles

In an early issue of RADIO BROADCAST will appear the first of a series of articles on how to revamp some of the most popular and widely sold of the manufactured radio receivers. Photographs and diagrams show explicity how the changes can be made. The first article describes the alterations which can be made on one of the most popular Atwater-Kent receivers.

BOOK REVIEW

A Useful Laboratory Handbook

RADIO FREQUENCY MEASUREMENTS. *By E. B. Moullin, M. A., A. M. I. E. E., Published by J. B. Lippincott Company, Philadelphia. 278 pages and 134 illustrations. Price $10.00*

THERE are a few books on radio subjects which are essential to the equipment of any serious worker in the interesting phase of communication engineering. One of these books is Professor Morecroft's *Principles of Radio Communication;* another is Van der Bijl's well known book, *Vacuum Tubes.*

Lately a third book has appeared that cannot be too well recommended to those who can digest Morecroft and Van der Bijl. This is a book on radio frequency measurements and is by no less a person that E. B. Moullin, who probably deserves more credit than any other for the development of the vacuum tube voltmeter, an instrument that is gradually coming into the wide use it deserves.

This book, the full title of which is *The Theory and Practice of Radio Frequency Measurements* is published in England by Charles Griffin and Company, and in Philadelphia by the J. B. Lippincott Company. It bears the date of 1926, which means that it is right up to the minute. It has been written for the advanced worker as a laboratory guide or manual and for those students who are anxious to know more of what goes on in radio circuits.

Mr. Moullin assumes that his readers know something of electrical theory—particularly their alternating current theory; the first chapter heading indicates this, being entitled "The Valve Generator." Early in the chapter the vacuum tube voltmeter is brought into evidence, and throughout the volume of 278 pages the generator and the voltmeter go hand in hand in all sorts of valuable and interesting measurements. Along with the laboratory practice involved, goes considerable mathematics, but not too much to obscure the issue. Mr. Moullin and other sound British engineers and physicists have carried out the mathematical groundwork underlying the work to be done in the laboratory, and there is no need for them to repeat all of their involved mathematical circumlocutions. The writer of this book has not done that; he has used enough to show the points at issue.

The remainder of the book is devoted to the measurement at high frequencies of the various electrical elements around which all radio phenomena are built. High frequency resistance measurements are outlined in detail; the problems of measuring capacity and inductance each get a chapter, and two chapters are devoted to measurements on antenna characteristics and on the intensity of radiated waves. In the latter there is considerable interest at the present time, and little has heretofore been published of methods by which measurements of the important quantities, such as field strength, antenna resistance and effective height, can be made. Mr. Moullin again brings out his ubiquitous vacuum tube voltmeter and his generator, and the answer is soon at hand.

With regard to the vacuum tube voltmeter, it seems worth while to point out that it is not the infallible instrument that many in this country would believe. This is particularly true of the "slide back" meter in which an a. c. voltage is balanced by a d. c. grid bias.

KEITH HENNEY.

The Microphone

The Theory and Application of the Various Forms of Microphones—Contact and Non-Contact Devices

By H. J. ROUND

THE term "microphone," originally used by Hughes to describe a loose contact device extremely sensitive to vibration, has been generalized to mean any piece of apparatus for converting rapid vibrational energy into electrical energy with similar vibrational characteristics. A number of such devices are now known; some are of scientific interest only, while others are used very extensively in industry.

Last month in these columns we printed a story about the inventor of the microphone, Emile Berliner, who came over to this country as an immigrant when he was nineteen years of age. This month, a little more about this device—the eye of the transmitter. In the accompanying article, Captain Round, of the British Marconi Company, describes the various types of microphones, and explains their applications. To the Encyclopædia Britannica *we are indebted for this article, for it has been especially written to appear in the 13th edition of that institution, due for publication this fall. The drawings were also supplied by the* Encyclopædia Britannica.

—THE EDITOR.

Microphones Proper.—A loose contact between any two conductors is microphonic. That is to say, when subjected to vibration there is no sharp definition between completely open circuit and completely closed circuit. In between these two states there is a condition where varying pressure alters the resistance, and if one or both of the substances making contact are subject to vibratory pressure, the vibration is reproduced as a varying current. The characteristic between pressure and current is only linear over small limits.

The action at the point of contact is not exactly known. When the current passing through the contact while in the microphonic condition

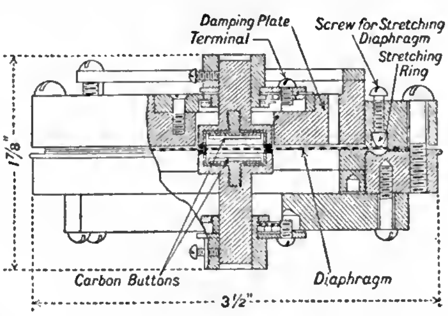


FIG. 1

is examined, it is found not to be absolutely constant, and this lack of constancy makes itself evident as a hiss in a telephone receiver. The discharge through a vacuum tube has a very similar sound when amplified.

The change of resistance with pressure varies greatly with materials used. Carbon in one form or another is universally recognized as the best material, in that the transitory stage between open and closed circuit is more marked than with other materials. This does not mean, however, that it gives the greatest change of resistance for a given change of pressure. A contact between gold electrodes, by delicate adjustment, can be put in a sensitive condition, and in the adjustment gives greater changes than carbon for the same change of pressure. A considerable amplification can be obtained with microphonic contacts, the output vibratory electrical energy being many times that of the input mechanical energy.

To Edison, Berliner, Hughes, and many others, we owe the introduction of the contact microphone and its development as a practical device, and microphones to translate noises and music have been produced in many forms.

The inventive drift has been towards multiple contacts and practically all contact microphones are now formed of prepared anthracite granules, the sound pressure being applied in various ways, usually by means of a diaphragm. In recent years a more accurate study of the response of microphones to sound pressure has been made, and two modern forms in which the response is practically independent of frequency have been made.

In the first form, the Western Electric carbon microphone (Fig. 1), a diaphragm of duraluminum is stretched to a natural period well above the frequency it is required to reproduce.

A type of air damping is applied to the diaphragm and it is allowed to rest on carbon granules. The resulting currents are practically independent of frequency.

In a second form, known as the Reisz microphone (Fig. 2), a diaphragm is practically dispensed with, and a layer of carbon granules is laid on a heavy non-conducting block, such as marble, being held in position by some material such as silk or thin rubber. The current response is obtained at right angles to the direction of application of pressure.

The carbon granule-air system of a thickness of about 2mm. forms a system of a very high natural period in depth, also damped by the natural friction of the carbon.

The resulting response is similar to that of the stretched diaphragm type described in the last paragraph. Lowering the period of the diaphragm or thickening up the layer of carbon granules in these two types have similar results.

These high quality microphones are not sensitive and have to be used with a vacuum-tube amplifier.

In commercial telephony this amplification is

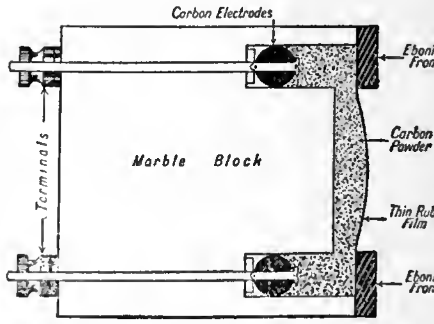


FIG. 2

not usually permissible, at least to any great extent, so that it is usual to greatly increase the sensitiveness by foregoing some of the accuracy of response.

Fortunately the human voice can be considerably distorted without lack of intelligibility and, by giving the diaphragm of the microphone a natural period in the middle of the important frequency ranges (about 800 cycles), amplifiers can be dispensed with owing to the increased response; music, however, cannot be reproduced with anything like fidelity. These microphones are also used well outside their range of linear response.

Granule microphones all suffer to some extent with packing, that is, a tendency for the carbon to set itself in a hard contact condition where change of resistance with pressure is least, and much time has been spent in an attempt to overcome this difficulty. The commercial solid back microphone is one of the best forms, but occasional shaking is still necessary.

Other Response Devices.—The best known of non-contact devices is the E. S. microphone, developed into an instrument of precision by the

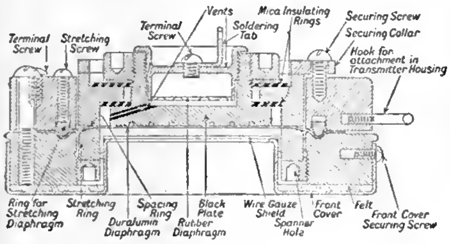


FIG. 3

Western Electric Company (Fig. 3). Here the same principle is used as in the carbon microphone. A high natural period diaphragm, air damped, forms one plate of a condenser, the other being a solid insulated metal piece spaced a few mils from the diaphragm. The chief use of this instrument is for measurement and for broadcasting. The amplification required is large.

Various magnetic microphones have been constructed; in fact, the first Bell microphone was practically the present receiver. The response with frequency is, however, a complex curve, although it is more linear with amplitude than a contact device. Moving coil devices have been produced by Sykes, Siemens-Halske, etc., the later forms of instrument being constructed so that the moving coil is the diaphragm.

In the Sykes microphone (Fig. 4), an annular ring of aluminum foil or wire is suspended in a

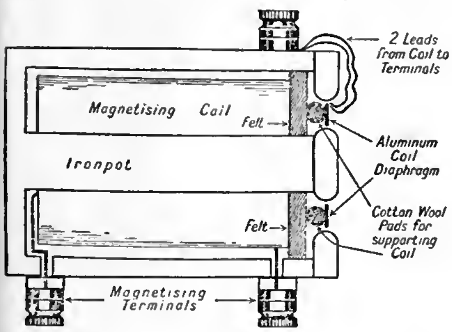


FIG. 4

magnetic field, and the response is sufficiently large to enable the method to be used for broadcasting. The law of response with frequency, although not nearly so correct as the electrostatic instrument, can largely be corrected for in the amplifier.

Thermal Devices.—Hot metal wires have been used for microphone purposes. The response is, however, small, except for very low frequencies, which property has been used by Tucker for gun ranging usually in connection with a resonance chamber.

Gas Discharge Devices.—Doctor Thomas of the Westinghouse Electric Company, and others, have investigated the use of point discharges but these devices have not come into general use.

A flame carrying a current is sensitive to sound but the effect is too small for practical purposes. The piezo-electric effect has also been used but not with much success, except for very high frequency work.

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

CONTRIBUTIONS to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. A prize of twenty-five dollars is given for the best idea used during each three-month period. The prize winner for the last period was announced in the August Radio Broadcast. *Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department,* Radio Broadcast, *Garden City, New York.*

C Potential from the Line Supply Unit

THE writer has found that the ordinary home constructed line supply unit may be very easily modified so that all C potentials as well as B potentials may be obtained. The circuit used is shown in the accompanying sketch, Fig. 11, and consists of the standard Raytheon circuit modified to include the resistances R_1, R_4, and R_5. R_1 is a 10,000 to 100,000-ohm variable resistance, and is used in supplying 90 to 100 volts plate voltage for radio frequency and first stage audio tubes. R_4 and R_5 are used in supplying the C or grid potential, and consist of two approximately 400-ohm potentiometers connected in series. The actual values of the resistances used for R_4 and R_5 will depend upon the grid potentials desired and the plate current supplied by the line supply, and may be determined from Ohms Law. Final adjustment should be made with the aid of a milliammeter in each plate circuit, in turn.

It is important that the 8-mfd. condenser be connected to the B negative as shown, and not to the C negative lead, as the 2-mfd.

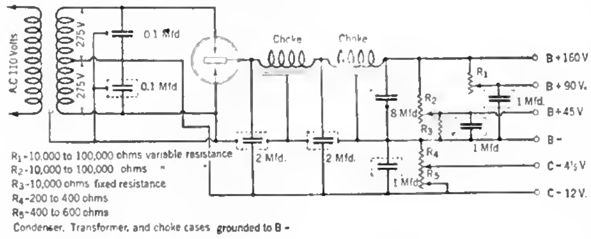


FIG 1

This diagram shows how it is possible to obtain C battery potential from a B battery line supply device. It is a standard Raytheon circuit modified so as to include the resistances R_1, R_4, and R_5.

condensers are, because the latter connection will suppress the bass notes.

All grid and plate leads going to the line supply are bypassed in the receiving set with 1-mfd. capacities so as to eliminate the effect of the lead impedance as far as possible.

The writer is using this line supply circuit with a high grade amplifier and a W.E. cone speaker, and finds the results somewhat superior to those obtained with the use of C batteries, as the ripple hum is less. This is due to the fact that any voltage ripple tends to modulate the grid and plates of the tubes in opposite directions so as to cancel.

So far the writer has not been able to eliminate all hum from the cone speaker but at present the hum is not audible more than a foot or two from the speaker with no signal, and the set out of resonance. As soon as a carrier wave is tuned in, all hum from the set disappears amid the much louder generator noises from the broadcast station.

William Wooley,
St. Louis, Missouri.

Interchangeable Coils

THE advent of the new UX tubes, together with the corresponding sockets, makes a very good solution to the problem of a satisfactory plug-in coil for home constructors.

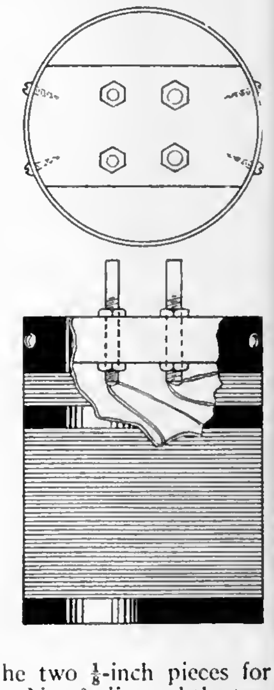
As shown in the diagram, Fig. 2, fasten a strip of wood across the bottom of the coil form with wood screws. This strip should be about $\frac{1}{2}$ inch thick, and $1\frac{1}{4}$ inches wide, rounded at the ends to fit.

In the center of this strip of wood, drill holes to correspond with the holes in an UX socket. The writer uses a No. 27 drill for the two small holes, and a $\frac{5}{32}$-inch one for the two large ones.

Then cut four pieces of brass rod about $1\frac{1}{4}$ inches long. Two of these should be of $\frac{1}{8}$-inch stock and the other two of $\frac{5}{32}$-inch

FIG. 2

Details are given in the accompanying text for the construction of a neat plug in coil arrangement. An UX socket forms an integral part of the construction



stock. Thread the two $\frac{1}{8}$-inch pieces for about $\frac{3}{4}$ inch with a No. $\frac{6}{32}$ die, and the two $\frac{5}{32}$-inch pieces for the same distance with a No. $\frac{8}{32}$ die. These threaded rods are then inserted in the holes drilled in the wooden strip, and held firmly in place with a hexagonal nut above and below the strip.

The four terminals of the coil are brought to these rods and soldered in place. The coil can then be inserted in the standard UX socket and a firm contact maintained.

The socket, of course, is wired into the circuit with proper regard for the identity of the coil prongs.

This makes a very neat and efficient installation, and coils can be interchanged in a second or two.

W. T. Mithoff,
Detroit, Michigan.

A Vernier Tickler for the Roberts

When tuning-in for distant stations, some form of micrometer adjustment for the tickler coil in the Roberts circuit will often be found helpful. The following method of accomplishing this has been tried out by the author and found extremely satisfactory in operation.

A small rubber band is employed to exert a pull on the tickler coil form. By rotating a shaft, mounted in a bushing in the panel of the receiver, a string, one end of which is fastened to the coil form, the other to the shaft, is made to wind up on the shaft, thereby obtaining a slow smooth variation in position of the tickler coil. This string will not unwind. Only one bearing is used and, since the string is wound out near the end of the shaft, a brake action is obtained. If a quarter-inch shaft is used, you will have two complete revolutions of the dial from zero regeneration to maximum. See Fig. 3

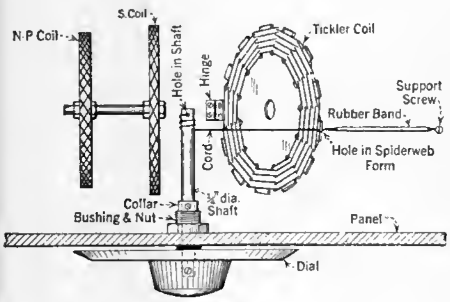


FIG. 3
Micrometer adjustment of the tickler coil in the Roberts receiver simplifies tuning considerably

Edward J. Kypke,
Boaz, Wisconsin.

Save Your Tubes!

Most of us who "roll our own" have tried hurried repairs with the screw-driver without first removing the tubes from our sets, with disastrous results, due to shorting the B-battery current; this often results in burned-out tubes. A good preventative is to obtain some small soft rubber tubing from the druggist, and to slip a length of it over all screw-drivers used in radio work, leaving just the end of the blade uncovered. This will permit safe use around the set, while tubes are lighted.

E. W. Coughlin,
District of Columbia.

In Coming Issues

The staff of Radio Broadcast Laboratory has prepared a splendid article on how to lay out and build an experimental radio and electrical laboratory in spare space in one's home. The article is most complete, with many helpful photographs and working drawings, together with a list of necessary tools so that the home constructer will not only have all the tools for his construction work but will have, if he follows the suggestions of the article, the base of a good radio experimental laboratory.

THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

AS WAS announced in the June RADIO BROADCAST, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

In response to many requests, lists of the various groups of apparatus tested and approved by RADIO BROADCAST Laboratory will be mailed to all inquirers without charge.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name......................................

Address......................................

Another Radio Show

A radio show will be held in Kansas City under the auspices of the Kansas City Electric Club in Convention Hall, Kansas City, Missouri, September 27 to October 2, inclusive. G. W. Weston is Secretary-Manager at 819 Gloyd Building.

LETTERS FROM READERS

Contributions from Readers on Various Subjects of Radio Interest—An Open Forum for All

For Cheaper Radio Apparatus

ONE way to prevent any diminution in the sale of radio parts, occasionally anticipated, would be to reduce the prices of radio equipment substantially, contends our correspondent, Mr. Frank P. Illsley, of Chicago. We can't all be Henry Fords but it is suggested that some of the larger radio manufacturers might profit by applying—on a small scale—the methods adopted so long ago by the motor car king.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

. . . . This problem (referring to the question of excessive charges on radio units) does not affect me personally; I can afford what I want, and also can get trade discounts if I so wish. My views are as a friend of the industry, and even more so of the farmers and others to whom radio might be such a boon if it were not being so shortsightedly exploited and maintained at a price level they cannot afford.

I know all the reasons asserted by the sellers as to why this *must* be, but there is nothing new in these; the same problems have always come up in every other industry, and the same finale has always arrived—that either a way had to be found to do what everyone said was impossible, and give the public enough for its money to induce buying, or a quiet buyer's strike resulted, and the sellers and the trade papers, depending on them, went broke in the end.

I ride much across country on test runs, etc., and so am able to note what percentage of farms have antennas; also to hear what farmer neighbors at our summer place have to say. I see what a small percentage of farms have sets, and hear how many of those who did decide to buy, have lost interest due to the limited quality of what they were able to afford. Should they, however, decide to invest in a cheap receiver not beyond their means, they can, it is true, get the service of market reports, etc., but after the first thrill has passed, and their ears tell them that the quality of music they receive is as metallic as that from the old phonograph they long ago tired of, and when they find that the price of better transformers or other audio amplifying units is as fanciful as it is, that it will cost them $25 or more for parts, and labor extra, to remodel their sets, or $100 or so to buy a factory-built one, they decide that either course is not for them.

They understand all the seller's problems, that what is "it" to-day may be obsolete in a year, that costs of distribution are high, etc., etc., but they know also that they as farmers must do business with no guarantee that their years will show them a profit, or with any protection against the high distribution costs on farm products.

Though it is becoming the fashion to cite Henry Ford overly often, there is nevertheless value in noting some facts in his course; the chief reason for his success has been his courage to set a price first and take the risk that it would thaw out a large enough volume of sales to be profitable thereafter. His too-immense success thereby in the past led to overplaying matters finally, but the policy even so proved that it could be overdone widely and still continue a gold mine.

The slump in the radio field is no secret to me, and the lay public senses it more widely than is perhaps realised. It is due partly to the monotonous sameness in most of the broadcasters' programs, but more to the inability of the average listener to get the quality of reception his ears demand, at the price he can afford. Given a capable set, he can perhaps "range" the air and pick out here and there, satisfying bits from this or that program.

But when I consider that Ford's entire engine costs less ($15) to build than some manufacturers ask for a unit which is merely a can containing a condenser, coil, and socket, all marked at the tidy price of a mere $20 per unit, or $60 to $100 for enough to make a set; when I see some dealer's window showing other electrical items such as fan motors, which contain several times the material and labor required for an audio transformer or impedance unit, but are priced lower, I wonder how many besides myself are struck by the disparity, and the seeds of a little revolt against buying anything more than is compulsory from the radio industry are thereby sown.

It is probably true that things are never as good or bad as they seem; the industry may face less of a slump than appears now likely. The impressions I have taken time to outline in the above may not be fully fitting the facts, but let me offer them as being broadly sketched, probably in the main warranted, and from a well-wisher—less of the industry than for radio and what it might do for farmers and great sections of the people, once it is brought to the needed level in price and quality.

Very truly yours,
FRANK P. ILLSLEY.
Chicago, Illinois.

From an "Universal" Enthusiast

FROM Oconomowoc—it's in Wisconsin!—comes the following epistle to our desk:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Your Laboratory Information Sheets are a most satisfactory addition to the magazine. I have an index showing where articles of interest can be found in various papers and magazines, including clippings, and your Laboratory Sheets were promptly filed therein.

I have assembled a "Universal" receiver and am thoroughly pleased with its performance. It brings in remote stations clearly and with plenty of volume. My daylight range is Omaha, St. Louis, Cincinnati, and Indianapolis. My evening range, Denver, Miami, San Antonio, New York. From April 21st until May 18th, I logged fifty-six stations before 11 P.M. Central Standard Time.

Very truly yours,
J. C. FINNEY,
Oconomowoc, Wisconsin.

Hears Australia on the Roberts

"WE HAVE much pleasure in advising you that it was our station you heard on the 25th of April. We would value any further reports you care to give us." Such is the inscription on the back of the photograph (which in reality is a post card), shown on the next page, and it is signed by the Broadcasting Company of Australia. The recipient is Mr. Karl Templin, of East Sound, Washington, who is to be complimented upon his reception of 3 LO, Melbourne. He used a five-tube Roberts for his accomplishment. The letter below is from Mr. Harding Gow, a friend of Mr. Templin's who constructed the receiver in question.

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York.
Sir:

I enclose the confirmation card received on Karl Templin's reception of 3LO, Melbourne. Please return it as it is one of his cherished possessions. I arrived here from Seattle on May 1st, and then Templin told me that he had picked up a strange station at 4 A.M. on April 25th. He

got the call as ALO, which I think was owing to the fact that he had no headphones. He gave me a description of the numbers he heard and showed me the dial settings. These latter checked with 3LO's wavelength. He said the program ended with a talk on the resources of Australia.

I wrote the letter to 3LO, hence my reason for writing you now. When signing off, the announcer used the word "evening," which put me on the track that it was real DX that my friend had heard. He had no broadcasting list of Australian stations.

I am a strong supporter of the Roberts receiver, and of Radio Broadcast, and am proud to have had a part, that of set builder, in the reception of the Australian broadcaster.

Very truly yours,
Harding Gow,
East Sound, Washington.

France is Behind in Radio

David Sarnoff, recently in France, gave it out that he was disappointed in radio development in that country. A letter to Radio Broadcast from a well-known British radio amateur visiting France, is in accord with this statement. He says:

Editor, Radio Broadcast,
Doubleday, Page & Company,
Garden City, New York
Sir:

Over here the wireless apparatus appears to me to be a long way behind our times. I visited the Paris Fair and I noticed the exhibitors still had exterior valves (tubes), unsprung bases, tapped inductances and generally one valve for all purposes. We have a French three-valve set and each of the three valves give different results though of the same type. Apparently they cannot afford to import American or British valves and apparatus, and have not the market or ability to make good ones of their own. The L. F. "Mico-Amph." costs, however, only 50 frs. (not $1.50 of your money), and other types are 37 and 40 frs. There are a quantity of small wireless papers. A Frenchman remarked to me that every boy when he leaves college starts to edit one! Wireless shops in the small towns have scarcely anything in stock, and we can't find wire, terminals, plugs, and sockets, or most small gear there.

Very truly yours,
H. E. Adshead,
Great Bardfield, England.

THE GENEVA PLAN

How Europe's Wavelengths Have Been Re-Allocated From a Central Bureau

By

Lawrence W. Corbett

SOME eighteen months ago the Office International de Radiophonie came into being. This is a union of members gathered from European broadcasting organizations for the discussion and formulation of plans for the benefit of all European listeners. The Secretary General of the Council is Arthur Burrows, one time "Uncle Arthur" of the British Broadcasting Company, while Admiral Carpendale, "second in command" of the present B. B. C., is President of the Council.

The work of the organization is divided under three headings; Legal, Technical, and Artistic. It is with the Technical Committee that we are concerned, and this section is presided over by M. Braillard, of Belgium.

When the Bureau first came into existence, of paramount importance was the chaotic state of affairs then prevalent in the European ether. The allocation of transmitting frequencies was then a matter of national concern, and the individual governments were not in a position to consider geographical positions on an international scale when assigning wavelengths to their own stations. The result was a hopeless tangle of overlapping frequencies, so serious in fact, that the B. B. C. had to state that it would not be possible to announce in advance any changes in the wavelengths of their stations necessitated by other stations pirating, knowingly or unwittingly, the wavelengths near enough to those they (the B. B. C.) were using to cause heterodyning.

It was only a few weeks ago that the Office de Radiophonie announced their plan for the reorganization of the whole frequency allocation system of Europe, and there are those who will have it that the eighteen months taken to form this plan is out of proportion to the good that will result. The more serious minded will, however, realize that the mere working out of the plan on paper would not have been feasible, and that practical applications of the system had to be tried out very thoroughly before any definite plan could be arrived at. Many times during the eighteen months have temporary wavelengths been assigned to various of the European stations for a try-out, and only by such experiments has it been possible to present conclusive evidence that the plan will work.

THE GENEVA PLAN

THE "Geneva Plan," as it has been called, which will come into effect at about the time that this article appears in print, has caused the wavelengths from 201.3 to 588.2 meters to be divided into 99 distinct channels, each separated from its neighbor by 10 kilocycles. Of these 99 channels, 83 are what are known as "exclusive" wavelengths, the remaining 16 being termed "common" wavelengths. The exclusive wavelengths are for the sole use of the particular broadcasting station to which they are allotted, while the common wavelengths are to be shared by those stations which have no exclusive wavelength. These latter will generally be low power stations, and when a common wave is alotted, care will be taken in its choice to choose a frequency that is not shared by another station geographically near at hand.

The 83 exclusive wavelengths have been shared out to the various countries according to the following list: Albania, 1; Austria, 2; Belgium, 2; Bulgaria, 1; Czecho Slovakia, 3; Denmark, 1; Esthonia, 1; Finland, 2; France, 9; Germany, 12; Great Britain, 9; Greece, 1; Holland, 2; Hungary, 1; Ireland, 1; Italy, 5; Jugo Slavia, 1; Latvia, 1; Lithuania, 1; Luxembourg, 1; Norway, 3; Poland, 4; Portugal, 1; Roumania, 2; Russia (West), 5; Spain, 5; Sweden, 5; Switzerland, 1.

The area coming under the jurisdiction of the Office is bounded as follows: On the North, by the Pole; the South, by the Mediterranean and Black Seas; the East, by a meridian drawn through Eastern Russia; on the West, by the Atlantic Ocean.

There are some two hundred broadcasting stations in Europe either active or shortly to become so, thus it is apparent that the common wavelength channels will be shared by about seven stations each. However, some of the common waves are shared by only two stations, according to the list drawn up by the Geneva Bureau, while other common waves are shared by as many as ten or so stations.

BRITAIN'S INTERPRETATION OF THE PLAN

LET us see how the new plan affects—Great Britain, for example. There are twenty-one broadcasters in that country, this figure including Daventry, the high power long-wave broadcaster, 5 XX. This latter will not, of course, be affected by the "Geneva Plan." Of the remaining twenty B. B. C. stations, 9 are main stations employing a power output of from 1500 to 3000 watts. The other 11 are relay stations using about 200 watts, and are for purely local service. Every B. B. C. station, until the "Geneva Plan" came into being, used a different frequency. Under the new regime, Great Britain has been given nine exclusive wavelengths for the main stations, the supposition of the Office de Radiophonie being that the B. B. C. would choose to operate all of its relay stations on common wavelengths shared by other nations.

Captain Eckersley, the chief engineer of the B. B. C., has decided not to do this, however. He has made up his mind that it would be better for the B. B. C. to reserve one of its exclusive wavelengths for the use of nine of the eleven relays. The other two relays will operate on common wavelengths, allotted by the Office de Radiophonie. This plan leaves eight exclusive wavelengths for the use of the nine main B. B. C. stations. Aberdeen and Birmingham will therefore share a wavelength, the other B. B. C. main stations being operated on the remaining seven exclusive wavelengths.

Captain Eckersley's plan was formed to obviate the necessity of some of the relays working as high as 1200 kc. (250 meters), a frequency which he considered would be too high for many of the receivers to tune-in. By his revision of the "Geneva Plan," he displays no lack of confidence in the Office de Radiophonie's original allocation. The Office, when allotting waves, unnecessarily specified which individual stations should operate on the exclusive waves given to the various countries, to simplify matters. Captain Eckersley is simply re-allocating the waves given to Great Britain among the stations in the B. B. C. chain. He is not taking any frequencies not allotted to Great Britain. In fact, if his plan of stacking most of the relays on one wavelength works, it will leave the common waves allotted for those relays freer for other uses. On the other hand, severe interference may be encountered by stocking nine relays on one wave, in which case the only remedy will probably be in utilizing all of the common waves allotted by the Office de Radiophonie for the relays.

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the twelfth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the August Radio Broadcast, *and will be reprinted in an early number.*

R800. (538) Magnetism. Magnetism.
Popular Radio. July, 1926. pp. 211ff.
"The Great Magnet that Rules Radio," E. E. Free.

The author discusses the nature of the magnetic and electric forces of the earth and their possible effects on radio waves. It is unknown to what the magnetism of the earth is due, but from observations it is known that the field is so distributed that it is impossible to locate any definite so-called poles of the earth's magnetic field. The region of the North and South magnetic poles is determined, although a gradual change is taking place from year to year, as is evidenced by the shifting of the magnetic dip of our compass needle. Daily and seasonal changes occur in the strength of the magnetic field at any one place, as is shown by the diagram.

The opinion is expressed that apparently the electricity and magnetism, and perhaps the gravitation of the earth, are problems which may be solved by the study of terrestial radio waves.

R112.6. Absorption: Reception. Reception.
Popular Radio, July, 1926, pp. 214ff.
"How to Get the Best Reception in Summer," R. H. Marriott.

Radio's four seasons, those characterized by strong signals, falling off signals, weak signals, and growing signals are compared to the four weather seasons, winter, spring, summer, and autumn. The seasonal conditions affecting radio reception, and thus varying the signal intensity, are summarized as follows:

1. The direct rays of the sun vary signal strength.
2. With no sun shining between transmitter and receiver, little variations occur.
3. Amount of humidity in the air at various localities may cause reflection or refraction.
4. Charges in the air with accompanying static and electric fields combine with radio waves and cause disturbances.
5. Light and heat waves, and the ionized condition of the air, cause changes.

For the above reasons the author recommends that receivers tune-in on local stations for good reception in summer.

R343.7. Alternating Current Supply. Raytheon
Popular Radio. July, 1926. pp. 230–233. Power Pack.
"Four New Combinations of Units," L. M. Cockaday.

Four more models of Raytheon power pack units are described. The first is a high-voltage power pack that is equipped with a relay in the A-battery circuit operated from the battery switch on the receiver. The second is a unit for lighting the last audio stage and supplying the necessary high voltage for the plate. The third is a unit to supply all B-battery current for the average receiver. The fourth is an arrangement whereby either high or low voltage may be obtained, depending on the value of the input voltage, which may be varied.

R113. Transmission Phenomena. Transmission
Popular Radio. July, 1926. pp. 234 ff. by Induction.
"How Energy Leaps the Chasm of Space by Induction," Sir Oliver Lodge.

Induction, says Sir Oliver Lodge, may be classed as electrostatic and electromagnetic. In the transfer of energy through space, the principle of induction plays an important part. Without it there would be no radio communication. After discussing the fundamental principles of induction, the writer states that, since magnetic and electric fields so to say interlock, and that one of these fields cannot be produced without the other, this relation is responsible for the generation and transmission of electromagnetic waves.

R384.1. Wavemeters. Wavemeters.
Radio Broadcast. July 1926, pp. 216–221.
"Wavemeters for the Home Laboratory," K. Henney.

The simple wavemeter consists of just a coil and a condenser. It may be calibrated by adjusting its setting to stations of known frequencies using an ordinary receiving set as a pick-up instrument, which is set into oscillation. Using a wavemeter in connection with a transmitting set, a coupling coil, a rectifier crystal, and some kind of indicating device are needed, in order to designate points of resonance. The heterodyne wavemeter consists of a simple Hartley circuit arrangement with grid meter or with phone jack in the plate circuit. Its uses are many, as enumerated, and together with the modulated oscillator described previously (Sept., 1925, issue pp. 604) many measurements of radio circuits and their characteristics can be made. The quartz crystal meter is used for fixed frequency measurements and is considered the most accurate standard in use to-day. Several circuit diagrams of crystal wavemeters are shown. Methods of calibrating wavemeters are described in detail, as by direct comparison with frequencies coming from outside stations through the regular broadcast receiver; by picking up harmonics from oscillating tubes; or by using both a short-wave receiver and a broadcast receiver at the same time.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Popular Radio*. July, 1926. pp. 242ff. *Short-Wave*.
"The Schnell Short-Wave Receiver," L. M. Cockaday.
Construction details and constants of the short-wave receiver used by F. H. Schnell are given in detail. Circuit diagrams and drawings are shown, the size of the coils for the different wave bands to be covered also being given.

R307. LABORATORIES. LABORATORY, *Radio News*, July, 1926. pp. 12ff. *Air Service*.
"The Air Service Radio Laboratories," Lieut. H. F. Breckel.
The writer gives an account of a visit made to the Air Service Laboratories at McCook Field, Dayton, Ohio. He tells of the radio research work going on in guiding airplanes through the air without pilots, and of the work being done in perfecting transmitters and receivers for airplane use. The radio beacon, which directs planes without the aid of ground visibility on the part of the pilot, is considered the most important development during the past year—from the standpoint of air service.

R220 & 240. CAPACITY AND RESISTANCE MEASUREMENTS. CAPACITY AND RESISTANCE CHARTS.
RADIO BROADCAST. July, 1926, pp. 222-223.
"Removing Mathematics from Resistance and Capacity Calculations," H. S. Davis.
Four charts are presented, by means of which resistances in parallel and capacities in series may easily be read, without resorting to mathematical calculation. Two charts, one covering resistances ranging from 5 to 100 ohms, the other ranges from 100 to 10,000 ohms, and two charts covering capacities from 0.0002 to 0.006 mfd. and 0.002 to 0.8 mfd., are shown. With suitable multipliers, these ranges can be extended.

R342.5. POWER AMPLIFIERS. AMPLIFIERS, RADIO BROADCAST. July, 1926, pp. 224-227. *A. C. Power*.
"A Quality Amplifier Power Supply," A. H. Lynch.
A description of the construction of a combined power stage and plate supply device, to be used in connection with any good receiver, is presented. The arrangement consists of a voltage step-up transformer, a rectifier, filter circuit, and a power audio amplifier using a power tube such as the UX-210. A circuit diagram, and photographs of the constructed units, are presented.

R113.5. METEOROLOGICAL. STATIC, RADIO BROADCAST. July, 1926, pp. 232-235. *Summer*.
"Where Summer Static Comes From," B. F. Dashiell.
The author relates the conditions of the atmosphere under which storms occur, telling us where the storm regions may be found, and points out in what way we may establish connection between weather conditions and radio reception. Thunderstorms have their origin in masses of warm and moist air. This air is in rapid motion and sets ions free from the atmospheric gasses, thus producing a high atmospheric charge. From this we experience our lighting discharges. These may be of various forms, as described.

R148. MODULATION. MODULATION.
RADIO BROADCAST. July, 1926, pp. 245-247.
"Technical Operation of Broadcasting Stations—Modulation," C. Dreher.
The Heising system of modulation, used in practically all of the broadcasting stations to-day, is discussed at some length. A large iron core choke coil, usually about 100 henrys inductance, is considered the governing part of the circuit. This coil prevents plate current variations of audio frequency being drawn from the high voltage plate supply, and is therefore known as the constant current system of modulation (Fig. 1). When the plate current of the modulator tubes (there should be at least two modulators to one oscillator when all of the tubes have the same capacity rating in a circuit) is varied, the plate current of the oscillator is changed correspondingly, thus varying the output energy. More than 35 per cent. to 40 per cent. modulation cannot be obtained without distortion if an equal number of modulators and oscillators are employed, says the writer. The degree of modulation may be determined either with a grid milliammeter, modulation meter, or oscillograph. The advantages of these systems is taken up in detail, diagrams being shown.

R007. LAWS: REGULATIONS. WAVELENGTH
RADIO BROADCAST. July, 1926, pp. 267. ASSIGNMENT.
"Frequency Channels Used by U. S. Radio Stations."
A list showing the assignments given to stations of various natures of transmission, such as broadcasting, commercial, experimental, amateur, etc., gives the following data: kilocycles, meters, form of transmission, kind of service, and remarks.

R330. ELECTRON TUBES ELECTRON TUBES
Radio News. July, 1926. pp. 30-31.
"Tubes Within Tubes," G. C. B. Rowe.
Photographic reproductions, accompanied by illustrative discussion of new types of vacuum tubes, are presented. The inventor of these "many tubes in one" is Doctor Loewe of Berlin. It is stated that, by placing the various elements of a receiving set, such as condensers and resistances, within the tube, shorter leads can be used and many difficulties overcome thereby.

R582. TRANSMISSION OF PHOTOGRAPHS. TELEVISION.
Radio News. July, 1926. pp. 36ff.
"The Latest Advance Toward Television," L. Fournier.
With the aid of revolving mirrors Professor Bélin has succeeded in receiving and reproducing a moving scene, being able to show complete images at the rate of ten per second. The method utilized for this purpose may readily be applied to radio transmission of pictures. The system is clearly pictured and described.

R330. ELECTRON TUBES. ELECTRON TUBES.
Radio News. July, 1926. pp. 50-51.
"A Departure in Radio Tube Design," H. K. Huppert.
The advantages derived from double-grid vacuum tubes is discussed. The tubes may be used either as radio-frequency amplifiers, detectors, or audio-frequency amplifiers. It is claimed that, with the aid of a second controlling device, it is possible to overcome capacity effects in tubes very effectively. Also, alternating current can be used on the filaments without having the objectionable 60-cycle hum present.

R356. TRANSFORMERS. TRANSFORMER CURVES.
Radio News. July, 1926. pp. 52f.
"How Should Transformer Curves Be Plotted?" S. Harris.

When plotting characteristics of audio frequency transformers, the scale to use in showing the frequency-voltage ratio should depend upon the physiological sensation produced, which necessitates, in the writer's opinion, a scale showing each octave the same value as any other octave. By plotting a curve logarithmically to the base 2, this is accomplished. Curves are shown depicting the advantages of such procedure.

R343.7. ALTERNATING CURRENT SUPPLY. RAYTHEON B UNIT.
Radio. July, 1926. pp. 13ff.
"How to Build a Plate-Current Supply Unit," G. M. Best.

Information is given concerning the best circuits and methods of assembly to be used in constructing a plate-supply unit from the 110-volt a. c. circuit. All of the models considered employ the Raytheon tube. In the first assembly, Jefferson transformers and chokes are used. In the second, General Radio parts are shown, while in the third, Dongan transformers and Thordarson chokes are employed. The fourth uses Acme parts. All-American parts are utilized in the fifth, and in the sixth, Silver-Marshall parts are shown. A circuit arrangement showing filament type rectifier tubes, and another showing a power amplifier with built-in rectifier, are explained.

R343.5. ELECTRON-TUBE RECEIVING SET. RECEIVER, *Short-Wave*.
Radio. July, 1926. pp. 17ff.
"An All-Around Short-Wave Receiver," L. Jacquet.

A short-wave receiver, range 30,000 to 2727 kc. (10–110 meters), is described. A detector and a one-stage amplifier is needed for either code or broadcast reception. The layout of the set, the list of necessary parts and the constructional details, are complete.

R343.7. ALTERNATING CURRENT SUPPLY. RECTIFIER, *B Eliminator*.
Radio. July, 1926. pp. 19–20.
"An Inexpensive B Eliminator," E. E. Griffin.

The constructional details of a 100- and 200-volt electrolytic B battery eliminator are outlined. Using parts on the market, readily obtainable at low cost, four rectifier cells are assembled and wired up according to the circuit diagram. According to the curve, which shows milliamps. output versus voltage, a steady drop in the voltage is noted as the output increases.

R132. AMPLIFYING ACTION. AMPLIFICATION.
Radio. July, 1926. pp. 23ff.
"Voltage Versus Power Amplification," J. E. Anderson.

The effects of resistance, impedance, and transformer coupling on the amplification, whether voltage or power amplification, is discussed, from a mathematical and quantitative standpoint. In resistance coupling the amplification constant, the ratio of the plate a. c. resistance to coupling resistance, and the amount of plate voltage applied, determine the increase in voltage amplification. How these values depend upon each other is shown in the graph, Fig. 1. In Fig. 2, a comparison is made between choke coil coupling and resistance coupling, with and without the effect of bypass condensers. It is evident, from the data presented, that high value bypass condensers cause considerable distortion.

In transformer coupling, contrary to general practice, the author presents arguments in favor of increasing the primary impedance considerably above that of the tube impedance for high amplification (Fig. 3). The effect of distributed capacity is to cause sharp variations in the amplification curve, especially if bypass condensers are added.

R270. SIGNAL INTENSITY. SIGNAL INTENSITY MEASUREMENT.
RADIO BROADCAST.
August, 1926, pp. 300–304.
"How Was Reception Last Night?" A. F. Murray.

Graphic recording of radio signals, programs as well as static disturbances, over a considerable period of time, will enable the radio engineer to devise ways and means of combating undesirable signals from entering the receiver, says the writer.

In order to record these signals, the equipment necessary is given as follows:

1. ANTENNA; well erected and located.
2. RECEIVER; preferably of the super-heterodyne type.
3. RECTIFIER; to change the received a. c. energy to pulsating d. c. in order to affect the galvanometer.
4. RECORDER; a sensitive micro-ammeter or Shaw recorder.
5. CALIBRATOR; a local oscillator, which is used to check on intensity of received signal.

The calibrator must be built accurately and should be well shielded, the one described being placed in a copper wash boiler. Resistances in the circuit are so arranged that accurate calibration can be obtained readily. The process of recording is outlined.

R343.5. ELECTRON-TUBE RECEIVING SET. RECEIVER, *"Local."*
RADIO BROADCAST. August, 1926. pp. 305–309.
"A High Quality Local Receiver," K. Clough.

This four-tube receiver, designed for high quality local reception, has one stage of r. f., detector, and two stages of a. f. amplification. The individual stages are shielded to minimize undesirable pick-ups. Circuit diagrams and a list of parts are shown for the beginner, everything being given in detail.

R376.3. LOUD-SPEAKING REPRODUCERS. LOUD SPEAKERS.
RADIO BROADCAST.
August, 1926. pp. 328–338
"Musical Reproduction Has Improved," A. F. Van Dyck.

A short survey of radio developments, relating in particular to broadcasting and improvements in receiver and loud speaker design, is given. Of the four fundamental parts of a receiver—antenna, tuning system, amplifying system, and loud speaker—the last mentioned has been the last to receive its due amount of attention. However, during the past year, the reproducer has undergone the needed changes, and now meets the specifications required. These changes have also been responsible for the modern phonograph's high quality of reproduction.

(*Continued on page 594*)

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(*Continued from page 592*)

R382. INDUCTORS. INDUCTANCES, *Transmitter.*
QST. July, 1926. pp. 29–30.
"Transmitting Coils," F. E. Handy.

Coils of low distributed capacity are needed for frequencies above 3000 kc. (wavelengths below 100 meters), says the writer, especially when using them in transmitter circuits. For that reason, edgewound coils should be avoided, and flat wound coils substituted, since these have a much lower distributed capacity. Five coils, with curves for each, are shown, giving the wavelength range they will cover with a specified variable condenser. The effect of the tubes on the frequency of the circuit when the former are connected, is to change the frequency a little, although this is hardly noticeable at the longer waves.

R138. ELECTRON EMISSION; IONIZATION. ELECTRON EMISSION.
Proc. I. R. E. June, 1926. pp. 325–331.
"Maintaining a Constant Reading on an Ammeter in the Filament Battery Circuit of a Thermionic Triode," E. H. W. Banner.

The distribution of current along the filament of a thermionic valve is not constant, on account of the emission which takes place from the filament to the anode. When the filament is not emitting, ammeters in each filament lead read the same value, but, when it is emitting, they are necessarily different; and, for the usual methods of connection between the anode battery and the filament, these readings are also both different from the non-emitting reading. It is necessary to have a constant reading for comparative tests, and, as the filament current cannot be maintained constant, a circuit has been devised in which there is no change in either ammeter reading when the anode battery is switched on.

R800 (621.353) BATTERIES. A, B, AND C SOURCES OF POWER.
Proc. I. R. E. June, 1926. pp. 345–372.
"Sources of A, B, and C Power for Radio Receivers," W. H. Holland.

This paper describes and gives characteristics of the various present-day sources of A, B, and C power for radio receivers; namely, storage batteries, dry primary batteries, trickle charger power units, and battery substitute devices. The development of radio storage batteries from the earliest types up to the highly specialized radio A and B batteries of to-day, having built-in charge indicators, visible water level, and spray-proof construction, is traced, and information is given on A socket power units containing such batteries in combination with newly developed trickle chargers. Announcement is made of a perfected aluminum electrolytic rectifier. B battery substitutes, embodying this rectifier, are described, and their electrical characteristics are given. Rectifiers and smoothing filters generally, and their application to radio uses, are discussed.

R 600. RADIO STATION. RADIO STATIONS, *Power of.*
Proc. I. R. E.. June, 1926. pp. 381–389.
"Choice of Power for a Radio Station," N. N. Tsiklinsky and V. I. Volynkin.

The cost of a radio station may be looked upon as the combined value of the buildings, the generating machinery, and the antenna with its masts and ground connection. It is shown in this paper that, for a given radio transmission, the necessary power (P) in the antenna, and the effective height (h) of the antenna, are connected by an equation $P=a+bh^2$. By means of this formula, the cost of the antenna and the masts, as a function of their dimensions, may be expressed as a function of the power; hence, all the curves of cost may be combined graphically. The resulting curve of total cost clearly shows that there is some power for which the cost of a radio transmitter is at a minimum. A method is also given for choice of power by which the annual expenses are at a minimum. The methods described above are illustrated by a determination of the power in the antenna and the heights of the masts for a radio station with a range of 3000 km., and operating on an optimum wavelength of 5070 m. (59.13 kc.). In this instance, the power for the least outlay is 30 kw., and, for the lowest annual expenses, 20 kw.

R383. RESISTORS. RESISTORS.
Wireless World. (London). June 30, 1926. pp. 892–893.
"Some Notes on High Ohmic Resistances," Dr. H. Kroencke.

High ohmic resistances of low current carrying capacity are used in radio circuits as grid leaks and coupling units. They should have no inductance or distributed capacity when used in high frequency circuits, which is the case with most units heretofore offered.

Doctor Loewe has perfected a resistance unit consisting of a thin metallic film deposited on a short tube of insulating material, by the phenomena of "sputtering," which gives a straight current-potential curve as shown.

R582. TRANSMISSION OF PHOTOGRAPHS. PHOTOGRAPHS BY RADIO.
Wireless World. (London). May 26, 1926. pp. 686–688.
"Picture Transmission by the Ranger System."

The Ranger system of picture transmission, as developed by the Radio Corporation of America, is described. This picture transmission is now in operation between the Marconi wireless stations on both sides of the Atlantic. The system is reliable, and the pictures, either in the form of line drawings or photographs, have reached a high standard of perfection, as is evidenced by the cuts shown. The image for transmission is in the form of a transparency, and is traversed by a pencil of light falling upon a photo-electric cell. Varying currents from the cell control the wireless transmitter, as is seen in the drawing. At the recording end, an inked stylus traverses the paper in synchronism with the analysis of the picture at the transmitter. There are 128 lines produced to the inch at the receiving end.

R384.1. WAVEMETERS. WAVEMETERS, *Short-Wave.*
QST. July, 1926. pp. 31–32.
"Short-Wave Wavemeters."

Three makes of short-wave wavemeters are pictured and described. These include the General Radio type 358 (range 14–240 meters, with 4 coils), the J. Gross and Co. instrument, (range 20–200 meters, with 2 coils), and the Radio Engineering Laboratories Type A (range 20 to 550 meters, with 3 coils).

(*Continued on page 596*)

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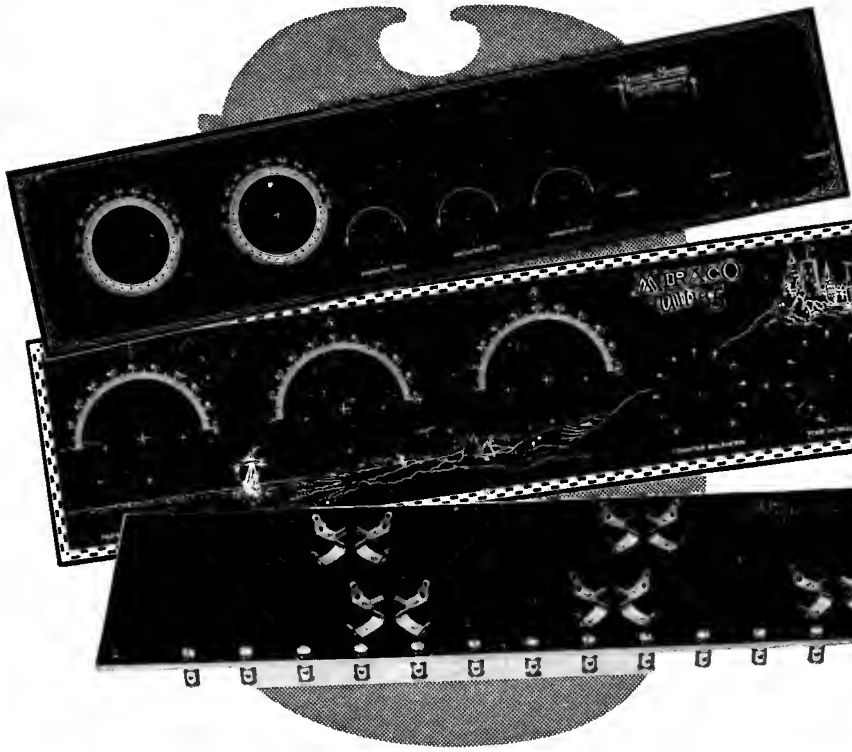

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(Continued from page 594)

R343. ELECTRON-TUBE RECEIVING SETS A PORTABLE RECEIVER FOR.
Proc. I. R. E. June, 1926. FIELD STRENGTH TESTS
pp. 333–344
"Portable Receiving Sets For Measuring Field Strengths at Broadcasting Frequencies," A. G. Jensen.
A measuring set for use in the field has been developed by the Bell Telephone Laboratories, and is here described. It is built on the principle of the super-heterodyne, with a sensitive meter in the plate circuit of the low frequency detector. A circuit diagram, and the method used in adjusting the set, are given.

R402. SHORT WAVES. SHORT-WAVE
QST. July, 1926. pp. 34–36. OPERATION.
"Progress and Plans at 5 Meters and Below," R. S. Kruse.
Tests conducted between stations at Staten Island, New York (2 EB), and Glastonbury, Connecticut, 1 XAQ, a distance of 120 miles, in order to determine what results could be obtained with 5-meter (60,000 kc.) operation, are related. Circuit diagrams of 5-meter transmitters, receivers, and antenna, are shown. It is suggested that more amateurs and experimenters try out this new wave-band in order to find out what its possibilities are.

R113. TRANSMISSION PHENOMENA. FEEDING THE
QST. July, 1926. pp. 8–14. ANTENNA.
"Feeding the Antenna," R. S. Kruse.
Transmission problems relative to antennas, and methods which may be used in connecting them to sources of energy, are discussed. A groundless antenna operates as a Hertzian oscillator, which is not the case with one that is grounded, the latter operating as an ordinary Marconi antenna. In coupling the antenna to the power source, it will be observed that the three forms, the vertical, the horizontal, and the bent forms, do not give the same results. They radiate differently. All of them have voltage antinodes at the ends, however, and oscillate at either a half wave or multiple thereof.
Two types of feed systems may be employed—current feed (large current at low voltage), or voltage feed (large voltage at low current). In the current feed system, coupling is made to the antenna at the center when operating at the fundamental, two connections being used. In the voltage feed system, connection may be made at one end through a series condenser. Diagram, Fig. 4, shows how either of these systems is used to work an antenna at some harmonic. In the voltage feed system, it is best to couple to the antenna through an inductive reactance rather than a capacity reactance, in order to reduce transmission on harmonics. The r. f. feed line should be kept low and free of standing waves. Mr. L. G. Windom, 8 GZ, 8 ZG, makes some very good suggestions regarding tuning a voltage feed system.
Using a two-wire r. f. feed line for the voltage feed, practically no energy is radiated from the line itself, and little trouble is experienced in making the system work. This two-wire line, used in the current feed system, makes adjustments easier and more flexible. Doctor Alexanderson suggests using a two-wire line which will not radiate together with a tunable antenna (as shown in Fig. 7). In order to have all of the tuning equipment in the operating room, the "Zeppelin" system is suggested as a very good type of voltage feed system.

R281.71. QUARTZ. QUARTZ
QST. July, 1926. pp. 15–16. MOUNTINGS.
"Quartz Crystal Mountings," R. M. Clayton.
Several forms of mountings for quartz crystals are shown and described. These include the method adopted by the General Radio Company, the Bureau of Standards, and the Stamps and Lidbury Company.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVERS,
QST. July, 1926. pp. 20–26. *Short-Wave.*
"Short-Wave Receiving Sets," L. W. Hatry.
Reference is made to designs of short-wave receiving sets covering the amateur bands to 1500 kc. (200 meters). The problems relative to methods of filtering the audio transformer output, single- or two-stage; the size and number of coils needed; the tuning of the antenna; the importance of the grid leak and condenser; the regeneration control; the r. f. chokes and the necessary constructional details of the set in general, are all fully discussed.

Italy's Share of International Radio

SOUTH AMERICA'S radio is being developed by a combination of interests of the United States, England, France and Germany. For some time, the large station at Buenos Aires has been in operation in transatlantic traffic and recently the Rio de Janeiro station has been put into commission. Now Mussolini, with his empire dreams, has suddenly awakened to the fact that in South America, his country has not been taken into the radio partnership.

Italy, according to a New York *Times* correspondent, has been invited to participate in the Rio affair with, however, an entrance fee of $1,000,000. But Mussolini can't see the price of admission so probably won't get any of the gate receipts.

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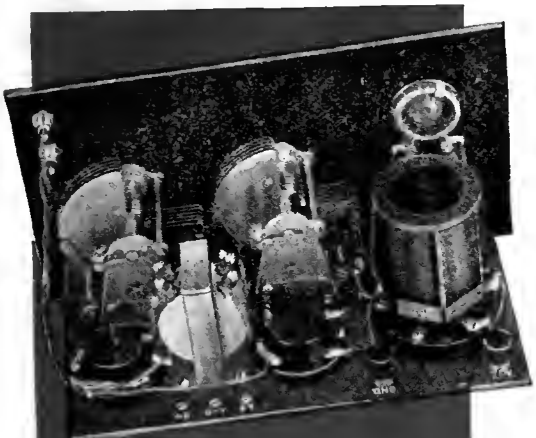

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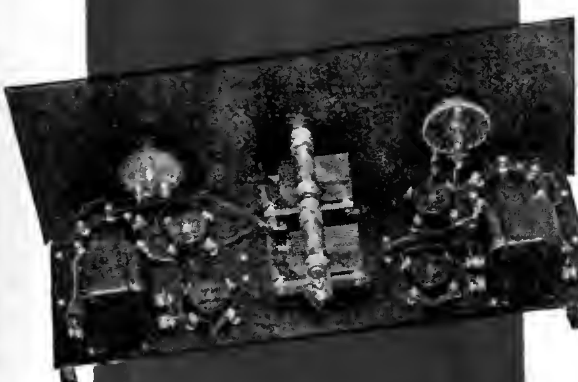

620 S-C Receiver

Commander Dyott on his expedition into the Brazilian Wilderness relied on the services of "Radio Broadcast" for the selection of the radio equipment that would enable him to keep in touch with civilization.

For the Short Wave Receiver—the most dependable and "distance getting" unit—"Radio Broadcast" selected the product of S-M engineers.

The receiver pictured on the left—a Silver-Marshall laboratory development—accompanies this expedition into the tropical wilderness. It is the unit that is most depended upon—when every other means of communication fails, the S-M Short Wave Receiver will still be on the job—depended upon and dependable.

635 SHORT WAVE KIT

This kit contains the essential units—duplicates of those found in Commander Dyott's receiver. It has a wavelength range of 18 to 150 meters with the four interchangeable plug-in coils supplied. The other essentials in the kit—all carefully matched and measured parts—are a coil socket, an antenna coupling condenser and two 140 mmf. tuning condensers. The 635 kit built up using a pair of 220 transformers for audio amplification, making a three tube set will give astounding results on short wave broadcast programs—in summer and also in the daytime. Many stations in America—and in other countries too, can be heard regularly on the shorter waves.

Price of 635 Kit complete with instructions, $23.00.

620 SILVER-COCKADAY RECEIVER

The S-C single control all wave four tube receiver requires no introduction, for it has been a marked success since early in 1926. It has been endorsed and approved in the editorial columns of practically every prominent magazine and newspaper.

This receiver was designed by Laurence M. Cockaday and McMurdo Silver, assisted by engineers of seven prominent radio manufacturers.

Intended for experienced fans as well as for the absolute novice, it may be built without cutting or soldering a single wire. In its design is incorporated a stage of tuned radio frequency amplification, a regenerative detector and two stages of audio amplification—four tubes in all—either dry cell, storage battery or power types. The wavelength range is 50 to 1500 meters—all with a single tuning control.

The S-C is so simple that any member of the family can operate it, yet its range is up to 2500 miles, its volume ample for home entertainment and its selectivity more than adequate for congested areas.

The 620 kit contains necessary parts exactly as specified by the designers, and the "Key to the S-C Receiver," which explains simply the assembling of the set. Price $59.25.

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